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DEPARTMENT OF THE INTERIOR
Hubert Work, Secretary

U. S. GEOLOGICAL SURVEY
George Otis Smith, Director

MINERAL RESOURCES

OF THE

UNITED STATES

1922

G. F. LOUGHLIN
Geologist in Charge, Division of Mineral Resources

PART II—NONMETALS

F. J. KATZ, Geologist in Charge

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Coal produced in the United States, 1807–1922 In pocket.
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MINERAL RESOURCES OF THE UNITED STATES, 1922—PART II.

FUEL BRIQUETS.[1]

By W. F. McKenney.

PRODUCTION.

In 1922 the fuel-briquetting industry was notably active and established a new high record of production. The total output of briquets was 619,425 net tons, an increase over 1921 of 220,476 tons, or 55 per cent. Comparison with the previous high record, made in 1920, shows an increase of more than 9 per cent. The progress of the industry since 1907 is shown graphically in Figure 1.

Fuel briquets produced in the United States in 1921 and 1922.[a]

	1921		1922	
	Net tons.	Value.	Net tons.	Value.
Eastern States	143,534	$1,047,906	170,152	$1,177,275
Central States	169,726	1,574,487	305,593	2,755,721
Pacific Coast States	85,689	1,009,908	143,680	1,511,930
	398,949	3,632,301	619,425	5,444,926

[a] List of producers shown on p. 4.

The increase in production may be attributed largely to the great miners' strike during the spring and summer. The closing of a large number of soft-coal mines and all the anthracite mines for five months led inevitably to a shortage of coal of domestic sizes. This shortage, together with the high prices that prevailed after midsummer, induced householders to look about for substitutes for the favored grades of coal, with the result that many purchased briquets.

The increase in production of briquets was most pronounced in the Central States, where the output was 80 per cent more than in 1921. In the Pacific Coast States there was an increase of 68 per cent and in the Eastern States an increase of 19 per cent. Of the total output 65 per cent was produced in Wisconsin and Pennsylvania, where there was

[1] The tables in this report were compiled by Miss J. M. Corse, of the U. S. Geological Survey, who has compiled the statistics on fuel briquets since 1911.

a demand for a substitute for anthracite for household use and where large quantities of material suitable for briquetting were available. The total output in Wisconsin was more than 150 per cent greater than in any other State.

Fuel briquets produced in the United States in 1917–1922.

Year.	Net tons.	Value.	Year.	Net tons.	Value.
1917	406,856	$2,233,888	1920	567,192	$4,623,831
1918	477,235	3,212,793	1921	398,949	3,632,301
1919	295,734	2,301,054	1922	619,425	5,444,926

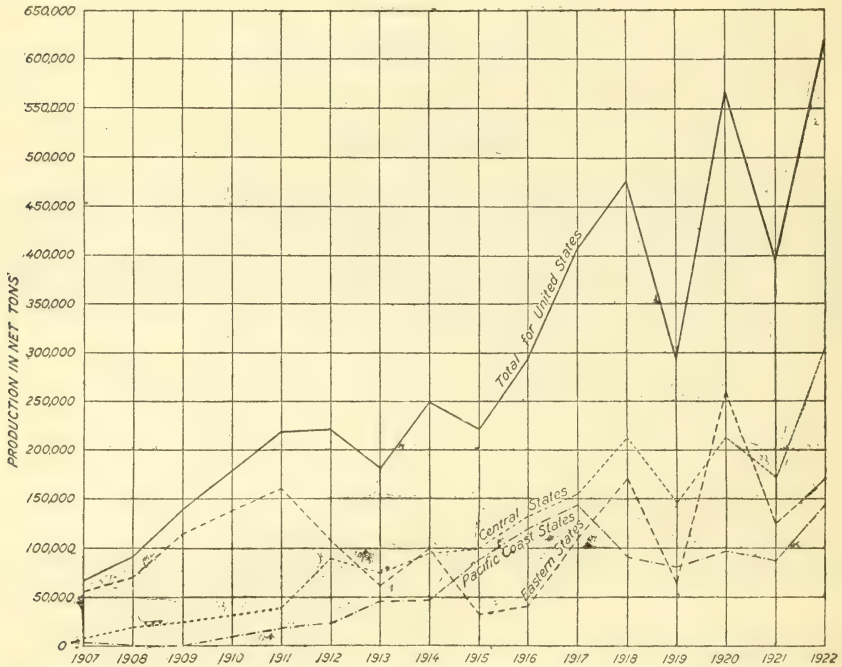

FIGURE 1.—Fuel briquets produced in the Eastern, Central, and Pacific Coast States and in the United States, 1907–1922.

The value of the briquets produced in 1922 was $5,444,926, an increase compared with the value in 1921 of $1,812,625, or 50 per cent. The increase over the value in 1920 was $821,095, or 18 per cent. Although the total value increased, the average value per ton decreased from $9.10 in 1921 to $8.79 in 1922. The decline was not due to a general lowering of prices of briquets, but to the fact that the low-priced product in Pennsylvania and Washington formed a larger part than usual of the total production. A better idea of the trend in prices of briquets may be gained from the following table, which shows the average value per ton at plants in Pennsylvania and the Central States.

Average value per ton (f. o. b. plant) of briquets produced in Pennsylvania and the Central States, 1911–1922.

Year.	Pennsylvania.	Central States.	Year.	Pennsylvania.	Central States.
1911	$2.37	$4.34	1917	$3.15	$6.81
1912	2.68	4.47	1918	4.11	8.17
1913	2.65	4.92	1919	4.17	8.47
1914	2.48	4.83	1920	5.60	9.23
1915	2.90	4.26	1921	6.14	9.28
1916	3.83	4.73	1922	5.93	9.02

The average value per ton was lowest in the Eastern States and highest on the Pacific coast. For the Eastern States the average value per ton in 1922 was $6.92, for the Central States it was $9.02, and for the Pacific coast $10.52. Prices obtained by individual plants ranged from $5.47 to $15.20, but the higher prices obtained for some briquets do not necessarily indicate a superior product, as the two factors which have the greatest influence in determining the price at the plant are the cost of the materials entering into the briquets and the prices of competing fuels.

RAW MATERIALS AND BINDERS.

With one exception all plants that reported production in 1921 were in operation in 1922, and no new plants began to operate. The plant of the General Briquetting Co., at New York City, was dismantled late in 1921. Of the 14 plants that reported, 6 used anthracite culm or fines as fuel constituent, 2 semianthracite, 1 a mixture of anthracite fines and bituminous slack, 1 semibituminous slack, 1 a mixture of bituminous slack and subbituminous coal, 2 carbon residue from the manufacture of oil gas, and 1 bituminous coal first subjected to low-temperature carbonization. The total quantity of raw fuel used was 613,444 net tons, of which 42 per cent was anthracite and semianthracite; 38 per cent semibituminous slack, bituminous slack, and coke; and 20 per cent subbituminous coal and oil-gas residue. The difference between this quantity of raw fuel and the 619,425 tons of briquets obtained, a gain in weight of 5,981 tons, was due to the addition of the binders.

Raw fuels used in making briquets in the United States, 1919–1922, in net tons.

Fuel.	1919	1920	1921	1922
Anthracite culm and fine sizes and semianthracite	118,595	356,877	190,964	254,563
Semibituminous and bituminous slack and coke	[a] 97,387	[a] 125,506	121,925	235,542
Lignite, subbituminous coal, and oil-gas residue	80,383	89,656	[b] 85,352	[b] 123,339
	296,365	572,039	398,241	613,444

[a] Includes no coke. [b] Includes no brown lignite.

Of the plants that were in operation during 1922, 2 used no binder, 4 used asphaltic pitch, 2 coal-tar pitch, 1 a mixture of asphaltic and coal-tar pitch, 1 mixed pitches, 1 sulphite liquor, 1 asphaltic oil and cornstarch, and 2 patent binders. Asphaltic pitch and coal-tar pitch, alone or in compounds, were the favored binders and were used in 79 per cent of the briquets produced.

Briquets produced in the United States in 1922, by type of binder used, in net tons.

Asphaltic pitch	252,084
Asphaltic pitch and coal-tar pitch, coal-tar pitch, or asphaltic oil and corn starch	236,720
Sulphite liquor, mixed pitches, patent binder, or no binder	130,621

BRIQUETTING PLANTS IN THE UNITED STATES.

The plant of the Johnson Fuel Co., at Scranton N. Dak., was idle throughout 1921 and 1922, and the plant of the General Briquetting Co., at New York City, was dismantled late in 1921. With these exceptions all other plants that reported in 1921 were operated in 1922.

Briquetting plants operated in the United States in 1922.

Group and State.	Name and address of operator.	Location of plant.	Date put in operation.	Raw fuel used.
Eastern States:				
New Jersey	Burnrite Coal Briquette Co., 543 New Jersey Avenue., Newark, N. J.	Newark	1920	Anthracite.
Do	Anthracite Manufacturing Corporation, 520 Brunswick Avenue, Trenton, N. J.	Trenton	1918	Do.
Pennsylvania	American Briquet Co., 402 Land Title Building, Philadelphia, Pa.	Lykens	1920	Do.
Do	Anthracite Briquette Co., Sunbury, Pa.	Sunbury	1919	Do.
Do	Lehigh Coal & Navigation Co., 437 Chestnut Street, Philadelphia, Pa.	Lansford	1909	Do.
Do	Scranton Anthracite Briquette Co., Dickson City, Pa.	Dickson City	1907	Do.
Virginia	Clinchfield Carbocoal Corporation, South Clinchfield, Va.	South Clinchfield.	1921	Coke made from high-grade bituminous coal.
Do	Delparen Anthracite Briquette Co., Parrott, Va.	Parrott	1915	Virginia semianthracite.
Central States:				
Missouri	Standard Briquet Fuel Co., 319 North Fourth Street, St. Louis, Mo.	Kansas City	1909	Arkansas semianthracite.
Wisconsin	Berwind Fuel Co., 122 South Michigan Avenue, Chicago, Ill.	Superior	1912	Semibituminous slack.
Do	Stott Briquet Co., Merchants National Bank Building, St. Paul, Minn.	do	1909	Anthracite fines and bituminous slack.
Pacific Coast States:				
California	Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, Calif.	Los Angeles	1905	Carbon (petroleum residue).
Oregon	Portland Gas & Coke Co., Gasco Building, Portland, Oregon.	Portland	1913	Do.
Washington	Pacific Coast Coal Co., 612 L. C. Smith Building, Seattle, Wash.	Renton	1914	Bituminous slack and subbituminous coal.

PEAT.

By K. W. Cottrell.

The peat industry in the United States made substantial progress in 1922. Only three companies discontinued business during the year, and eight new ones entered the field. Three of these new companies produced a small quantity in 1922, and the others were preparing to operate in 1923.

The quantity of peat produced in the United States in 1922 increased nearly 100 per cent over that produced in 1921; the value increased 53 per cent. Peat used as fertilizer or as an ingredient of fertilizer increased 96 per cent in quantity and 47 per cent in value. Peat used as an ingredient of stock food increased in both quantity and value. The peat fuel reported for 1922 showed a considerable increase over the quantity and value reported for 1921. As there was a shortage of coal during the winter of 1922, more peat may have been utilized as household fuel than that here reported.

The 23 plants reporting production of peat in 1922 were distributed as follows: Michigan, 4; New York, 4; California, 3; New Jersey, 4; Illinois, 2; Massachusetts, 2; Florida, Maine, New Hampshire, and North Carolina, 1 each. New Jersey was the largest producer, with an output of 39,095 short tons, valued at $193,940; California ranked second, with an output of 10,988 short tons, valued at $115,943. Illinois ranked third, but the State total may not be published, as there were only two producers.

The quantity of peat moss or litter imported from January 1 to September 21, 1922, according to the Bureau of Foreign and Domestic Commerce, was 3,394 tons, only 1 per cent less than in the whole year 1921. No exports of crude peat or peat products were reported for 1922.[1]

The consumption of peat and peat moss (production plus imports) was 64,074 tons, valued at $421,269, in 1922, against 33,856 tons, valued at $282,873, in 1921.

Peat produced in the United States, 1916–1922.

Year.	Number of plants reporting.	Short tons.	Value.	
			Total.	Average.
1916	13	52,506	$369,104	$7.03
1917	18	97,363	709,900	7.29
1918	25	107,261	1,047,243	9.76
1919	15	69,197	705,532	10.20
1920	18	73,204	921,732	12.59
1921	21	30,406	260,119	8.55
1922	23	60,680	397,729	6.55

[1] Statistics of imports and exports compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

Peat and peat moss used in the manufacture of peat products in the United States in 1921 and 1922.

Kind of product.	Production.		Imports.		Consumption.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1921.						
Fertilizer and fertilizer ingredient	29,460	$251,046			29,460	$251,046
Stock food	[a] 946	[a] 9,073			[a] 946	[a] 9,073
Fuel	(a)	(a)			(a)	(a)
Moss	(a)	(a)	3,450	$22,754	[a] 3,450	[a] 22,754
	30,406	260,119	3,450	22,754	33,856	282,873
1922.						
Fertilizer and fertilizer ingredient	57,747	369,165			57,747	369,165
Stock food	[b] 1,893	[b] 20,864			[b] 1,893	[b] 20,864
Fuel	1,040	7,700			1,040	7,700
Moss	(b)	(b)	4,805	24,489	[b] 4,805	[b] 24,489
	60,680	397,729	4,805	24,489	65,485	422,218

[a] Small production of fuel, moss, and stable litter included under "Stock food."
[b] Small production of moss and stable litter included under "Stock food."

The following individuals and companies reported to the Geological Survey that they produced crude peat or peat products in the United States in 1922:

Alphano Humus Co., Whitehall Building, New York, N. Y.
Blaine, J. H., Hopewell Junction, N. Y.
Central Peat Corporation, Capac, Mich.
Chapman, I. S., & Co. (Inc.), 937 Third Street, San Bernardino Calif.
Craig, William H., Fishkill, N. Y.
Day, James H., 35 South Street, Milford, N. H.
First Massachusetts Carbon Fuel Co., 306 Main Street, Worcester, Mass.
Humus Natural Manure Co., 1964 Broadway, New York, N. Y.
Hyper-Humus Co., Newton, N. J.
McElhone, Asa, Fishkill, N. Y.
Manito Chemical Co., Peoria, Ill.
Marcrum, J. G., Netcong, N. J.
Morisite Process Corporation, First National Bank Building, Detroit, Mich.
National Humus & Chemical Co., Chassell, Mich.
Pacific Humus Co., 205 Central Building, Pasadena, Calif.
Peat Engineering Co., 189 Exchange Street, Bangor, Me.
Peat Products Corporation, 552 David Whitney Building, Detroit, Mich.
Phos-Pho Germ Manufacturing Corporation, New Bern, N. C.
Ranson, Robert, St. Augustine, Fla.
Riverside Orange Co. (Ltd.), Arlington Heights, Riverside, Calif.
Sims, Alfred F., Sag Harbor, N. Y.
Victory Fertilizer Co., 54 North Street, Boston, Mass.
Wiedmer Chemical Co., Pierce Building, St. Louis, Mo.

ASPHALT AND RELATED BITUMENS.

By K. W. Cottrell.

GENERAL FEATURES.

The sales of asphalt and related bitumens in the United States in 1922 showed general increases in both quantity and value over those of the preceding year. These increases ranged from 11 per cent in quantity and 13 per cent in value of native asphalt and related bitumens to 29 per cent in quantity and 15 per cent in value of asphalt manufactured from domestic petroleum. Asphalt manufactured from Mexican petroleum showed an increase of 37 per cent in quantity and 18 per cent in value.

The number of operators reporting the production of asphalt and related bitumens was 46, of whom 16 produced native asphaltic materials, 14 manufactured asphalt from petroleum of domestic origin exclusively, 10 from petroleum of Mexican origin, and 6 from both domestic and Mexican petroleum.

Manufactured asphalt.—In the production of asphalt from domestic petroleum California, with 9 operators reporting, ranked first; Texas, with 3 operators reporting, ranked second; and Illinois, with 5 operators reporting, ranked third, in both quantity and value.

Ozokerite.—The imports of ozokerite and other mineral waxes in 1922 were 5 per cent greater than those in 1921. The average value per pound dropped to 4 cents, 2 cents less than in 1921.

Ichthyol.—The Hy-Gen-Ol Laboratory, Spring Valley, N. Y., which succeeded the Meadows Chemical Corporation in December, 1922, reports the manufacture of ammonium ichthyolate at the Meadows Durant plant. The imports of ichthyol and ichthyol substitutes in 1922 decreased about 2 per cent from those in 1921. The average value of the imported material dropped from $1.42 a pound in 1921 to $1.20 in 1922.

PRODUCTION.

Native asphalt and related bitumens sold in the United States, 1917–1922.

[Value f. o. b. mine.]

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1917	81,604	$773,424	1920	198,497	$1,213,908
1918	60,034	780,808	1921	296,412	1,985,583
1919	88,281	682,989	1922	327,792	2,253,180

Native asphalt and related bitumens sold in the United States, 1917–1922, by States.

[Value f. o. b. mine.]

State.	1917		1918		1919	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
California	6,009	$19,447	3,260	$12,516	[a] 3,614	$15,037
Oklahoma	[b]	[b]	[b]	[b]	[c] 4,323	18,187
Utah	35,192	569,325	31,072	663,258	[d] 33,992	406,610
Other States [e]	40,403	184,652	25,702	105,034	[f] 46,352	243,155
	81,604	773,424	60,034	780,808	88,281	682,989

	1920		1921		1922	
California	[a b]	[a b]	[a b]	[a b]	[a b]	[a b]
Oklahoma	[c] 7,522	$45,898	[c] 25,573	$87,587	[c] 47,597	$164,035
Texas	[a b]	[a b]	[a b]	[a b]	[a] 152,567	558,274
Utah	[d] 63,522	659,176	[d] 10,371	190,808	[d] 29,704	623,207
Other States [e]	[a] 127,453	508,834	[a] 260,468	1,707,188	[a] 97,924	907,664
	198,497	1,213,908	296,412	1,985,583	327,792	2,253,180

[a] Bituminous rock.
[b] Included under "Other States."
[c] Bituminous rock and grahamite.
[d] Gilsonite and wurtzilite (elaterite).
[e] 1917: Colorado, Kentucky, Oklahoma, and Texas; 1918: Kentucky, Oklahoma, and Texas; 1919: Illinois, Kentucky, and Texas; 1920 and 1921: California, Kentucky, and Texas; 1922: California and Kentucky.
[f] Bituminous rock, grahamite, and impsonite.

Asphalt manufactured in the United States from petroleum and sold at refineries, 1917–1922.

[Value f. o. b. refinery.]

Year.	From domestic petroleum.		From Mexican petroleum.	
	Short tons.	Value.	Short tons.	Value.
1917	701,809	$7,734,691	645,613	$7,441,813
1918	604,723	8,796,541	597,697	9,417,818
1919	614,692	8,727,372	674,876	7,711,510
1920	700,496	11,985,457	1,045,779	14,272,862
1921	624,220	9,048,221	908,093	11,761,358
1922	805,145	10,385,925	1,242,163	13,899,407

Asphalt and asphaltic material manufactured in the United States from petroleum and sold at refineries, 1922, by varieties.

[Value f. o. b. refinery.]

Product.	Solid and semisolid products of less than 200 penetration (asphalt).		Semisolid and liquid products of more than 200 penetration (flux[a]).		Grand total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
From domestic petroleum:						
Paving[b]	267,933	$3,702,151	23,761	$270,569	291,694	$3,972,720
Roofing and waterproof[c]	[d] 247,966	[d] 3,431,600	(d)	(d)	247,966	3,431,600
Mineral rubber[e]	4,881	149,414	.....	.....	4,881	149,414
Other[f]	29,058	397,781	105,661	1,105,549	134,719	1,503,330
Road oil[g]	.....	.....	125,885	1,328,861	125,885	1,328,861
	549,838	7,680,946	255,307	2,704,979	805,145	10,385,925
From Mexican petroleum:						
Paving[b]	494,462	5,966,000	59,777	595,977	554,239	6,561,977
Roofing and waterproof[c]	418,470	4,620,465	109,681	928,108	528,151	5,548,573
Mineral rubber[e]	9,312	197,799	.....	.....	9,312	197,799
Other[f]	30,270	335,135	55,959	586,652	86,229	921,787
Road oil[g]	.....	.....	64,232	669,271	64,232	669,271
	952,514	11,119,399	289,649	2,780,008	1,242,163	13,899,407

[a] Flux: Liquid asphaltic material used in softening native asphalt or solid petroleum asphalt for paving, roofing, waterproofing, and other purposes.

[b] Paving asphalt: Refined native asphalt and asphaltic cement, fluxed and unfluxed, produced for direct use in the construction of sheet asphalt, asphaltic concrete, asphalt macadam, and asphalt block pavements, and also for use as joint filler in brick, block, and monolithic pavements.

[c] Roofing and waterproofing asphalt: Asphalt and asphaltic cement used in saturating, coating and cementing felt or other fabric and in the manufacture of asphalt shingles.

[d] Small quantity of roofing and waterproof flux of more than 200 penetration included under roofing and waterproof flux of less than 200 penetration.

[e] Mineral rubber: Asphalt and asphaltic cement used by the rubber industry.

[f] Other solid and semisolid products: Asphalt and asphaltic cement used as dips and in the manufacture of insulating material, acid-resisting compounds, putty, mastic, and briquets and not included in the preceding definitions. Other liquid products: Petroleum asphalt used in the manufacture of saturant, paint, varnish, or other coating, exclusive of fuel oil and not included in the preceding definitions.

[g] Road oil: Residual asphaltic oil used for surface treatment.

Asphalt sold at mines and refineries in the United States, 1917–1922, by varieties.

[Value f. o. b. mine or refinery.]

Variety.	1917		1918		1919	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Petroleum asphalt[a]	701,809	$7,734,691	604,723	$8,796,541	614,692	$8,727,372
Bituminous rock	41,919	136,255	25,346	92,238	53,589	262,309
Gilsonite	35,049	532,989	30,848	606,639	(b)	(b)
Wurtzilite			(b)	(b)		
Ozokerite	18	1,000	37	45,399	.....	.....
Other bituminous substances[c]	[b] 4,618	[b] 103,180	3,803	36,532	34,692	420,680
	783,413	8,508,115	664,757	9,577,349	702,973	9,410,361

Variety.	1920		1921		1922	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Petroleum asphalt[a]	700,496	$11,985,457	624,220	$9,048,221	805,145	$10,385,925
Bituminous rock	132,353	531,134	284,037	1,788,715	298,047	1,629,440
Gilsonite	56,204	548,776	10,066	178,224	29,693	622,107
Other bituminous substances[c]	9,940	133,998	2,309	18,644	52	1,633
	898,993	13,199,365	920,632	11,033,804	1,132,937	12,639,105

[a] From domestic petroleum only.

[b] Included under "Other bituminous substances."

[c] 1917: Grahamite and maltha; 1918, 1920, 1921, and 1922: Grahamite and wurtzilite (elaterite); 1919: Elaterite, gilsonite, grahamite, and impsonite.

IMPORTS AND EXPORTS.[1]

Native asphalt and bituminous rock imported into the United States, 1919–1922, by countries.

[General imports.]

Source.	1919		1920		1921		1922	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
North America:								
Canada	38	$1,088	88	$2,832	18	$634	52	$2,251
Mexico	6,566	31,587	15	66	.....	.....	3	25
West Indies—								
British—								
Barbados	31	3,069	68	8,128	101	14,760	36	6,590
Trinidad and Tobago	51,062	350,431	100,783	892,545	75,305	754,503	85,480	721,891
Other British	.....	.....	.....	.....	896	4,200	1,120	11,200
Cuba	636	17,270	274	7,447	371	7,020	113	2,711
Dutch	(a)	10	.....	.....	.....	.....	.....	.....
South America:								
Colombia	6	169	6	207	18	1,556	(a)	5
Venezuela	47,309	211,875	27,179	156,282	51,676	343,535	37,449	247,920
Europe:								
Belgium	.....	.....	.....	.....	2	30	(a)	3
Denmark	.....	.....	.....	.....	.....	.....	49	1,516
France	.....	.....	.....	.....	.....	.....	39	948
Germany	.....	.....	.....	.....	140	1,889	312	4,481
Netherlands	.....	.....	.....	.....	2	25	.....	.....
United Kingdom—								
England	.....	.....	.....	.....	.....	.....	6	920
Ireland	.....	.....	1	109	.....	.....	.....	.....
Asia:								
Turkey in Asia	.....	.....	.....	.....	6	1,133	.....	.....
Oceania:								
Philippine Islands	.....	.....	.....	.....	(a)	5	(a)	2
	105,648	615,499	128,414	1,067,616	128,535	1,129,290	124,659	1,000,463

a Figures for quantity not available.

Ozokerite and other mineral waxes imported for consumption in the United States, 1917–1922.

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1917	899,405	$90,510	1920	4,272,341	$499,758
1918	1,809,459	147,805	1921	8,548,542	546,054
1919	3,748,080	454,840	1922	8,989,972	371,161

Ichthyol and ichthyol substitutes imported for consumption in the United States, 1917–1922.

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1917	58,397	$36,232	1920	98,135	$79,133
1918	65,752	39,452	1921	76,020	107,752
1919	30,976	38,975	1922	74,330	89,150

[1] Statistic of imports and exports compiled by J. A. Dorsey, of the U. S. Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

Asphalt exported from the United States, 1917–1922.

Year.	Unmanufactured.		Manufactures of.	Total.
	Short tons.	Value.		
1917	30,107	$587,256	$585,472	$1,172,728
1918	22,108	577,654	577,936	1,155,590
1919	40,208	1,103,930	606,918	1,710,848
1920	51,706	1,356,116	842,074	2,198,190
1921	45,367	1,178,038	621,224	1,799,262
1922	57,362	1,344,440	[a] 1,261,125	[a] 2,605,565

[a] Inclusive of value of 588,636 squares (10 by 10 feet) of roofing asphalt ($870,200). Corresponding exports not specifically shown prior to 1922.

Asphalt exported from the United States in 1922, by countries.

Country.	Unmanufactured.		Manufactures of, except roofing.	
	Short tons.	Value.	Short tons.	Value.
North America:				
Canada	16,432	$286,229	10,199	$184,858
Central America—				
British Honduras			[a]	18
Costa Rica	2	65	1	126
Guatemala			[a]	33
Honduras			1	61
Nicaragua	1	38	[a]	17
Panama	366	6,558	33	3,084
Salvador	1	20		
Mexico	164	4,183	90	4,809
West Indies—				
British—				
Jamaica			1	63
Trinidad and Tobago			[a]	1
Other	7	211	3	154
Cuba	286	5,289	32	1,814
Dominican Republic			[a]	73
Dutch	1	40	1	70
French			1	14
Haiti	46	980	19	865
South America:				
Argentina	364	11,736	147	5,034
Brazil	362	11,272	651	28,151
Chile	1,043	26,240	33	1,364
Colombia	10	222	33	1,804
Ecuador	393	7,375	6	922
Guiana—				
British	1	12	43	2,923
Dutch			[a]	12
Peru	326	9,682	195	5,547
Uruguay	45	1,536	6	802
Venezuela	15	317	3	275
Europe:				
Belgium	772	20,518	387	30,019
Denmark	181	6,161		
France	2,458	65,696	102	4,015
Germany	1,823	69,062	22	1,300
Iceland and Faroe Islands			6	171
Italy	197	9,915	[a]	13
Netherlands	255	11,276		
Norway	10	575	[a]	20
Spain	36	828	908	22,534
Sweden	565	10,951	52	1,049
Switzerland	4	116		
United Kingdom—				
England	11,110	282,149	640	35,178
Ireland	171	4,151	44	1,770
Scotland	599	15,178	40	1,400

[a] Less than 1 ton.

Asphalt exported from the United States in 1922, by countries—Continued.

Country.	Unmanufactured.		Manufactures of, except roofing.	
	Short tons.	Value.	Short tons.	Value.
Asia:				
China	1,789	$52,908	72	$3,201
East Indies—				
British—				
Ceylon	77	1,891	2	84
India	776	27,648	251	8,162
Straits Settlements	25	800	(a)	40
French Indo-China	48	1,560		
Hongkong	388	10,219	10	420
Japan	7,888	180,744	134	11,785
Java and Madura	167	6,010	5	313
Kwangtung, leased territory	181	4,662	7	867
Palestine and Syria			(a)	25
Philippine Islands	965	21,158	4	456
Siam	189	3,617		
Africa:				
British—				
East	36	719	1	460
South	202	7,804	89	3,915
Egypt	213	6,846	(a)	20
French			2	132
Portuguese East Africa	68	1,472	2	143
Oceania:				
British—				
Australia	4,981	120,692	421	17,906
New Zealand	1,323	27,109	58	2,633
	57,362	1,344,440	14,757	390,925

a Less than 1 ton.

CONSUMPTION.

Asphaltic material consumed in the United States, 1917–1922, in short tons.

1917	1,587,284	1920	2,023,665
1918	1,356,009	1921	1,916,205
1919	1,445,178	1922	2,446,024

WORLD'S PRODUCTION.

Native asphalt, related bitumens, and bituminous rock produced in principal producing countries, 1913–1921, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	1919	1920	1921
Austria-Hungary	6,051	5,931	2,197	a151	a259	(b)	a1,003	a1,095	a1,160
Cuba (exports)	1,587	879	441	489	473	450	(b)	(b)	(b)
France	41,471	35,555	11,707	14,381	12,068	10,104	18,117	22,252	34,249
Germany	105,460	81,756	32,434	31,541	12,321	7,980	12,554	31,904	(b)
Italy	171,097	119,853	47,650	16,829	8,645	22,309	78,000	106,642	91,800
Japan	2,260	2,007	1,975	2,302	3,873	2,997	6,674	6,930	6,934
Mexico	(b)	(b)	388,318	(b)	(b)	(b)	(b)	(b)	(b)
Peru	(c)	(c)	(c)	12,080	8,131	14,915	14,033	17,162	11,834
Poland (Galicia)	1,353	(b)	(b)	(b)	(b)	(b)	299	368	260
Rumania	(b)	(b)	(b)	(b)	(b)	(b)	750	1,056	14,122
Spain	d5,582	5,765	4,521	7,316	1,817	3,692	4,564	4,222	3,533
Switzerland (exports)	50,368	32,848	17,222	20,506	14,764	1,788	8,888	h16,653	(b)
Trinidad e	f230,861	f112,800	g6,110	130,847	134,034	72,550	95,523	143,501	121,651
United States	84,008	72,473	68,720	89,336	74,030	54,462	80,087	180,074	268,899
Venezuela (exports)	85,170	45,305	28,983	44,611	49,360	h46,453	h45,936	h23,452	h48,489

a Austria only.
b Figures not yet available.
c Prior to 1916 figures combined with those for coal.
d Exclusive of 4,638 metric tons of bituminous rock.
e Includes small quantity of manjak.
f Fiscal year, Apr. 1 to Mar. 31.
g 9 months, Apr. 1 to Dec. 31.
h Production.

PRODUCERS.

The following operators reported to the United States Geological Survey that they produced asphaltic material from crude petroleum in the United States in 1922:

Asphaltum & Oil Refining Co., 2475 East Ninth Street, Los Angeles, Calif.
Atlantic Refining Co., 3144 Passyunk Avenue, Philadelphia, Pa.
Byerlyte Co., 2484 West Fourth Street, Cleveland, Ohio.
Central Refining Co., Lawrenceville, Ill.
Craig Oil Co., Toledo, Ohio.
Freeport Gas Co., Freeport, Tex.
Gulf Refining Co., Frick Building Annex, Pittsburgh, Pa.
Indian Refining Co., 244 Madison Avenue, New York, N.Y.
King Refining Co., 255 Holbrook Building, San Francisco, Calif.
Magnolia Petroleum Co., Box 1667, Dallas, Tex.
Mexican Petroleum Corporation, 120 Broadway, New York, N. Y.
Paraffine Companies (Inc.), 34 First Street, San Francisco, Calif.
Pierce Oil Corporation, 25 Broad Street, New York, N. Y.
Pioneer Asphalt Co., Lawrenceville, Ill.
Pioneer Paper Co., 247 South Los Angeles Street, Los Angeles, Calif.
Producers Refining Co., Bakersfield, Calif.
Prudential Oil Corporation, 110 William Street, New York, N. Y.
Roseberg Oil Co., 2474 East Ninth Street, Los Angeles, Calif.
Seaside Oil Co., Summerland, Calif.
Sinclair Refining Co. of Louisiana, 45 Nassau Street, New York, N. Y.
Standard Asphalt & Refining Co., 208 South La Salle Street, Chicago, Ill.
Standard Oil Co. of California, 200 Bush Street, San Francisco, Calif.
Standard Oil Co. of Indiana, 910 South Michigan Avenue, Chicago, Ill. (plants in Illinois, Indiana, and Missouri).
Standard Oil Co. of Louisiana, Baton Rouge, La.
Standard Oil Co. of New Jersey, 26 Broadway, New York, N. Y.
Sun Co., Finance Building, Philadelphia, Pa.
Texas Co., Houston, Tex.
Union Oil Co. of California, A. G. Bartlett Building, Los Angeles, Calif.
United States Asphalt Refining Co., 90 West Street, New York, N. Y.
Warner Quinlan Asphalt Co., 79 Wall Street, New York, N. Y.

Native asphalt and related bitumens were produced commercially in this country in 1922 by the following operators:

American Asphalt Association, 918 Wainwright Building, St. Louis, Mo.
American Rock Asphalt Co., Texarkana, Tex.
City Street Improvement Co., 400 California Street, San Francisco, Calif.
Continental Asphalt & Petroleum Co., Continental Building, Oklahoma, Okla.
Fort Smith Asphalt Co., Fort Smith, Ark.
Gilson Asphaltum Co., 1900 Land Title Building, Philadelphia, Pa.
Hy-Gen-Ol Laboratory, Spring Valley, N. Y.
Kentucky Rock Asphalt Co., 712 Paul Jones Building, Louisville, Ky.
Natural Rock Asphalt Corporation, Greenville, Ky.
Ririe & Montandon Co., 818 Gunter Building, San Antonio, Tex.
Sattler & Stevens, Carpinteria, Calif.
Texas Rock Asphalt Co., San Antonio, Tex.
Tipton, J. O., Ada, Okla.
United States Elaterite Products Co., Salt Lake City, Utah.
Utah Gilsonite Co., Watson, Utah.
Uvalde Rock Asphalt Co., San Antonio, Tex.

FLUORSPAR AND CRYOLITE.

By Hubert W. Davis.

FLUORSPAR.

The domestic fluorspar industry showed considerable improvement during 1922 from the severe slump of the preceding year. The gain was due principally to the demand for fluxing material in the steel industry, which took about 86 per cent of the total shipped.

FLUORSPAR MINED AND SHIPPED.

The shipments of fluorspar from domestic mines in 1922 increased 305 per cent in quantity and 250 per cent in value as compared with those in 1921. The general average price per ton f. o. b. mines or shipping points for all grades in 1922 was $17.88, a decrease of $2.83 from the average in 1921. The highest average price in 1922 was reported from New Hampshire and the lowest from Colorado.

The exact quantity of crude fluorspar mined can not be ascertained, because at most of the smaller mines only the cleaned material is weighed. The total quantity of merchantable fluorspar recovered by mining and milling in 1922 showed an increase of 122 per cent over 1921.

Merchantable fluorspar recovered in 1921 and 1922, by States.

State.	1921		1922		
	Short tons.	Percentage.	Short tons.	Percentage.	Number of producers.
Illinois	24,904	41.57	82,309	61.77	12
Kentucky	24,467	40.84	46,216	34.68	25
Colorado	4,103	6.85	2,044	1.53	5
Nevada			280	.21	1
New Mexico	4,914	8.20	1,760	1.32	4
Arizona	525	.88			
New Hampshire	685	1.14	650	.49	1
Utah	315	.52			1
	59,913	100.00	133,259	100.00	49

Fluorspar produced[a] in the United States, 1880–1922.

Year.	Illinois.		Kentucky.		Other States.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1880–1901							178,117	$1,067,655
1902–1917	986,334	$6,404,498	[b] 310,498	[b] $2,336,737	[b] 62,575	[b] $482,553	1,359,407	9,223,788
1918	132,798	2,887,099	87,604	2,069,185	43,415	509,197	263,817	5,465,481
1919	92,729	2,430,361	32,386	883,171	13,175	212,042	138,290	3,525,574
1920	120,299	3,096,767	46,091	1,246,942	20,388	374,838	186,778	4,718,547
1921	12,477	315,767	15,266	294,513	7,217	113,814	34,960	724,094
1922	83,855	1,493,188	52,484	970,059	5,257	67,918	141,596	2,531,165
							2,302,965	27,256,304

[a] Beginning with 1906 figures represent shipments from mines.
[b] Small quantity from Colorado and Tennessee included with Kentucky.

Such details of the shipments of fluorspar from 1919 to 1922, by States, as may be published without revealing statistics of individual producers, except by permission, are given in the following table:

Domestic fluorspar sold, 1919–1922.

State.	Gravel.			Lump.			Ground.			Total.		
	Short tons.	Value.		Short tons.	Value.		Short tons.	Value.		Short tons.	Value.	
		Total.	Average.		Total.	Average.		Total.	Average.		Total.	Average.
1919.												
Illinois	81,026	$1,962,934	$24.23	4,246	$133,993	$31.56	10,373	$446,224	$43.02	92,729	$2,430,361	$26.21
Kentucky	29,470	770,381	26.14							32,386	883,171	27.27
Colorado	b 12,088	b 184,044	15.23	b 1,087	b 27,998	25.76				9,687	150,739	15.56
New Mexico										2,346	37,643	16.05
Other States[a]										1,142	23,660	20.72
	b 122,584	b 2,917,359	23.80	b 5,333	b 161,991	30.38	10,373	446,224	43.02	138,290	3,525,574	25.49
1920.												
Illinois	103,486	2,396,322	23.16	8,332	381,171	36.27	8,481	537,151	43.32	120,299	3,096,767	25.74
Kentucky	39,997	1,029,195	25.73	2,178			3,916			46,091	1,246,942	27.05
Nevada	530	b 13,332	17.61	(b)	b 8,608	20.30	2			532	22,070	18.66
New Hampshire	b 202			268						202		
Utah				156						268		
Arizona	25									181		
Colorado	10,076	157,768	14.96	2,776	195,000	22.52				12,852	251,308	19.55
New Mexico	470			5,883						6,353	101,460	15.97
	b 154,786	b 3,596,617	23.24	b 19,593	b 584,779	29.85	12,399	537,151	43.32	186,778	4,718,547	25.26
1921.												
Colorado	3,143	39,907	12.70							3,143	39,907	12.70
Illinois	8,208	146,746	17.88	1,099	80,838	21.39	3,170	235,981	40.00	12,477	315,767	25.31
Kentucky	11,714	185,451	15.83	1,689			1,863			15,266	294,513	19.29
New Mexico	1,650	21,450	13.00	991			866			3,507	60,186	17.16
New Hampshire	b 567	b 13,721	24.20	(b)	(b)					567	13,721	24.20
	b 25,282	b 407,275	16.11	b 3,779	b 80,838	21.39	5,899	235,981	40.00	34,960	724,094	20.71
1922.												
Colorado	2,309	20,169	8.73							2,309	20,169	8.73
Illinois	76,537	1,243,151	16.24	1,722	96,033	18.57	5,596	368,649	36.42	83,855	1,493,188	17.81
Kentucky	45,680	774,086	16.95	2,629			4,175			52,484	970,059	18.48
New Mexico	1,008	12,320	12.22	820			352			2,180	30,992	14.22
Other States[a]	b 690	b 15,353	22.25	b 78	b 1,404	18.00				768	16,757	21.82
	b 126,224	b 2,065,079	16.36	b 5,249	b 97,437	18.56	10,123	368,649	36.42	141,596	2,531,165	17.88

[a] 1919: Arizona, Nevada, New Hampshire, and Utah; 1922: New Hampshire and Utah.

[b] Some lump spar included with gravel.

FLUORSPAR INDUSTRY, BY STATES.

Colorado.—The fluorspar mined in Colorado in 1922 was obtained from Wagonwheel Gap, the Jamestown district, and the newly opened deposit near Cowdrey, Jackson County. Development work at the property near Cowdrey was started early in 1922, and the openings consist of two shafts and several open cuts and pits on the outcrop. At a point somewhat more than 100 feet vertically below the outcrop a crosscut tunnel has been driven to the vein, along which drifts have been run. About 800 feet of underground work has been done. A crushing plant, ore bins, and a small power plant were constructed, and if further development warrants it the owners plan to erect a mill with a daily capacity of 100 tons.

Illinois.—The mine and mill of the Hillside Fluor Spar Mines, on the eastern extension of the Rosiclare vein, were put into operation about May 1, 1922. This new mine has a shaft connecting three levels, the lowest of which is 350 feet deep. It is electrically equipped throughout and includes a mill concentrating building for the close separation of fluorspar from impurities.

The Fairview Fluorspar & Lead Co. produced a small amount of fluorspar from a surface pillar above water level in the Good Hope mine. Its Extension mine was pumped out in October, and production was begun again on a larger scale. A vein of fluorspar a short distance west of the Blue Diggings vein was opened by a prospect shaft 220 feet deep and a 40-foot crosscut to the vein. This new mine, which has been named the Argo, gives promise of becoming a large producer.

The Rosiclare Lead & Fluorspar Mining Co. finished sinking its new shaft at the Daisy mine to the 400-foot level. Production in its main workings continued on a reduced scale throughout the year.

The Ohio Valley Fluorspar Co. did considerable development work by churn drill, slopes, and shafts at its properties near Cave-in-Rock.

At the Eichorn mine, near Rosiclare, development work was continued throughout the year. The shaft was put down to 350 feet, and about 300 feet of drifts were run at the 200-foot level. A railroad switch was constructed.

The Webber-Wood Spar Mining Co. did some prospecting on its property near Rosiclare and is sinking a shaft.

One of the large steel companies was engaged in prospecting by diamond drills in the vicinity of Hicks and Karbers Ridge.

Kentucky.—The Keystone Fluorspar & Lead Co., operating the Blue & Marble mine near Mexico, Ky., greatly increased its milling capacity, and the installation of new jigs and screen equipment has resulted in improved separation and removal of practically all lead concentrates. Three shafts connected by tram track with the mill are active producers and are being sunk to connect up a working level at 200 feet across the entire property, a distance of 2,000 feet.

At the Macer mine, on the La Rue vein, development work was under way, and three prospect shafts with fluorspar showing in each have been sunk. The shafts are being sunk deeper, to points where the vein carries more fluorspar.

The Big Four Fluorspar & Ore Co. carried on development work at its Big Four mine, opening more than 700 feet of continuous levels

at a depth of 100 feet. A 100-ton modern concentrating plant with steel head frame and steel housing is planned for 1923.

The Diamond Spar Co. was organized in 1922 to develop a property near Salem. The main shaft is down to 100 feet, but the vein has not yet been reached by crosscutting.

The Memphis property, near Marion, which has been inactive for several years, was reopened in 1922 and produced both acid and fluxing fluorspar.

Much activity in procuring options and purchasing properties by steel companies in the western Kentucky district was reported.

Nevada.—A small quantity of fluorspar was mined by the Continental Fluorspar Co. from its mine near Beatty, Nev., but no shipments were made.

New Hampshire.—The output in New Hampshire was obtained from the Stoddard mine, near Westmoreland, Cheshire County, and was shipped to the steel plant at Worcester, Mass.

New Mexico.—The lease of the Great Eagle mine, near Lordsburg, Grant County, N. Mex., was surrendered to the owners on February 1, 1922. The mine was unproductive during 1922, but the owners shipped from stock on hand a carload of ground fluorspar and a small quantity of fluxing material.

The Tortuga mine and mill, near Mesilla Park, Dona Ana County, were inactive the greater part of the year. A small quantity of ground fluorspar was shipped for use in the glass industry at Muncie, Ind. Some fluxing material was also shipped.

It has been reported that a fluorspar deposit about 6 miles north of Cliff and 38 miles from Silver City has recently been opened and is yielding 25 tons a day, which is hauled by trucks to Silver City, where it is loaded into cars and shipped to Birmingham, Ala., and Chicago, Ill.

Utah.—The operator of the Silver Queen mine, near Clive, Tooele County, Utah, reported that the local markets were poor owing to decreased operations of steel plants that obtain fluorspar from this mine. Some fluorspar was shipped to a cement plant whose product was giving trouble, the setting time being a little off. It was thought that the free silica might be the cause of the trouble, and the fluorspar was used in an attempt to volatilize some of the silica in the limestone and to cause a more ready and complete reaction between the lime and silica. The fluorspar gave a more readily fusible mix, and the percentage of insoluble matter in the cement was decreased, but the setting difficulty was not corrected, and the test was discontinued.

STOCKS OF FLUORSPAR.

According to the reports of producers the total quantity of fluorspar in stock at the mines or at shipping points at the end of 1922 amounted to 33,337 short tons, a decrease of 26 per cent from the stock at the end of 1921. As the quantity of fluorspar in stock piles is of necessity partly estimated, there are variations in the mine reports from year to year that prevent an absolute balance between the quantity mined and the quantity shipped and in stock. When the stocks on hand at the end of 1921, which were thought to be the largest ever accumulated by producers, were shipped they proved to have been considerably overestimated. In compiling the follow-

ing table the figures representing stocks for 1921 have therefore been adjusted accordingly, and certain stocks that are believed to be non-commercial have been dropped. Data on consumers' stocks are noted under "Consumption" (p. 20).

Stocks of fluorspar at mines or shipping points in 1921 and 1922, by States, in short tons.

State.	1921	1922
Arizona	549	400
Colorado	2,160	1,880
Illinois	24,982	22,691
Kentucky	16,646	7,471
Nevada	250	530
New Hampshire	118	45
New Mexico	260	50
Utah	315	270
	45,280	33,337

IMPORTS AND EXPORTS.[1]

The imports of fluorspar into the United States in 1922 amounted to 33,108 short tons and were the largest since 1910, when 42,488 tons was imported. The imports in 1922 showed an increase of 432 per cent in quantity and 332 per cent in value, as compared with 1921. The value at the foreign ports averaged $9.04 a ton.

The imports were equivalent to about 26 per cent of the domestic shipments of gravel fluorspar, as compared with about 25 per cent in 1921. England was the principal source of the imports in 1922, supplying 72 per cent of the total; Germany ranked second. It is understood that several thousand tons of the German material containing 85 per cent of calcium fluoride and not more than 5 per cent of silica was sold for about $16.50 a short ton at tidewater. Small quantities of ground fluorspar were received from Germany during 1922, and notwithstanding the increased tariff the price at which it is sold is a source of some competition to American producers. The material from South Africa was obtained from a mine in the Transvaal and is understood to have averaged 98 per cent of calcium fluoride and less than 0.5 per cent of silica. Practically all the Canadian fluorspar was reported to have been shipped to steel plants at Gary, Ind.

By the tariff act of 1922 the import duty on fluorspar was increased from $1.50 a long ton ($1.34 a short ton) to $5.60 a long ton ($5 a short ton).

The distances that domestic fluorspar must be transported from mines to steel plants in the Lehigh and Susquehanna valleys of Pennsylvania are generally much greater than the distances that English fluorspar must be carried from the ports of entry to these plants, but unless ocean freight rates are moderate, foreign fluorspar is not in a position to enjoy much advantage in American markets, for the reason that it is not generally of so high a grade as the mechanically treated domestic product, and as fluorspar is of value chiefly according to its purity, purchasers should find that the purer

[1] The statistics of imports were compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

American fluorspar is more efficient and consequently cheaper in the end.

The producers of fluorspar reported exports in 1922 amounting to 2,296 tons, valued at $40,966.

Fluorspar imported into the United States, by countries, in 1921 and 1922.

Country.	1921			1922		
	Short tons.	Value.		Short tons.	Value.	
		Total.	Average.		Total.	Average.
England	1,644	$12,031	$7.32	23,836	$206,950	$8.68
Canada	4,370	52,855	12.09	2,877	32,679	11.36
Germany	215	4,420	20.56	5,804	49,196	8.48
British South Africa				486	8,415	17.31
Belgium				71	1,187	16.72
Czechoslovakia				34	761	22.38
	6,229	69,306	11.13	33,108	299,188	9.04

Fluorspar imported into the United States in 1922, by ports of entry.

Port of entry.	Short tons.	Value.	
		Total.	Average.
Buffalo	44	$484	$11.00
New York	3,273	36,668	11.20
Philadelphia	19,366	164,960	8.52
Maryland	6,531	51,656	7.91
Los Angeles	257	3,043	11.84
San Francisco	576	6,102	10.59
Washington	228	4,080	17.89
Dakota	2,833	32,195	11.36
	33,108	299,188	9.04

CONSUMPTION.

The market for the bulk of the fluorspar sold in the United States depends on the condition of the steel industry, and the demand fluctuates with the production of basic open-hearth steel. Most of the domestic gravel and some of the lump fluorspar, together with most of the imported fluorspar, are consumed as flux in basic open-hearth steel furnaces and to a smaller extent in other metallurgical operations. The shipments of gravel fluorspar in 1922 constituted 89 per cent of the total shipments of domestic fluorspar, as compared with 72 per cent in 1921. Fluorspar is also used as a flux in iron blast furnaces, iron foundries, and gold, silver, copper, and lead smelters; in the manufacture of glass, enameled and sanitary ware, sodium fluoride used as a wood preservative, and hydrofluoric acid; in the electrolytic refining of antimony and lead; in the production of aluminum; and in other minor applications.

The producers of about 70 per cent of the basic open-hearth steel made reported that they consumed 72,962 short tons of fluorspar in 1922 and had stocks on hand amounting to 45,647 short tons on January 1, 1923. If the steel companies that did not report consumed a like proportion of fluorspar, the figures given indicate a total consumption in all steel plants of about 104,000 tons in 1922 and total stocks of about 65,000 tons on hand January 1, 1923. Similar information indicated a consumption in 1921 of 68,400 tons for all plants and stocks on January 1, 1922, of about 30,000 tons. The reports show that the consumption of fluorspar per ton of steel

produced in 1922 ranged from 5.3 to 18.5 pounds and averaged 7.4 pounds. In 1921 it ranged from 4.8 to 18.6 pounds and averaged 8.2 pounds.

The shipments of domestic fluorspar plus the imports minus the exports should give from year to year an index to the quantity available for consumption and indicate its relative increase or decrease. The total quantity of all grades of fluorspar available for consumption in 1922 was 172,408 short tons, an increase of 319 per cent compared with 1921. The general relation between the total supply of fluorspar and the output of open-hearth steel may be noted by comparison of the following tables:

Fluorspar available for consumption, 1918–1922, in short tons.

Year.	Sales of domestic spar.	Imports for consumption.	Exports.	Available for consumption.
1918	263,817	12,572	(a)	276,389
1919	138,290	6,943	(a)	145,233
1920	186,778	24,612	b 2,764	208,626
1921	34,960	6,229	.....	41,189
1922	141,596	33,108	b 2,296	172,408

a Not available.
b Reported by producers; none recorded by Bureau of Foreign and Domestic Commerce.

Open-hearth steel produced in 1918–1922, in long tons.

[From reports of the American Iron and Steel Institute.]

Year.	Basic.	Acid.	Total.
1918	32,476,571	1,982,820	34,459,391
1919	25,719,312	1,229,382	26,948,694
1920	31,375,723	1,296,172	32,671,895
1921	15,082,564	507,238	15,589,802
1922	28,387,171	921,812	29,308,983

SHIPMENTS, BY USES.

The large dependence of the fluorspar industry on the steel industry is clearly shown by the fact that by far the greater part of the fluorspar shipped is taken by steel manufacturers. There is considerable variation in the average price per ton of the fluorspar shipped to the several industries. The high price of fluorspar for hydrofluoric acid and glass and enameled ware is due to the high quality demanded.

Fluorspar shipped in 1921 and 1922, by uses.

Use.	1921				1922			
	Percentage.	Short tons.	Value.		Percentage.	Short tons.	Value.	
			Total.	Average.			Total.	Average.
Steel	73.09	25,553	$407,230	$15.94	86.44	122,403	$1,987,586	$16.24
Foundry	4.35	1,521	30,632	20.14	2.12	2,998	57,011	19.02
Glass and enamel ware	16.02	5,599	224,137	40.03	6.29	8,904	323,116	36.29
Hydrofluoric acid (including fluorspar used in manufacture of aluminum)	5.24	1,833	52,455	28.62	3.38	4,782	118,648	24.81
Miscellaneous	1.30	454	9,640	21.23	.15	213	3,838	18.02
	100.00	34,960	724,094	20.71	98.38	139,300	2,490,199	17.88
Exported to Canada	.....	.....	.....	.....	1.62	2,296	40,966	17.84
	100.00	34,960	724,094	20.71	100.00	141,596	2,531,165	17.88

PRODUCTION BY COUNTRIES.

Fluorspar produced in principal countries, 1918–1922, in metric tons.

Country.	1918	1919	1920	1921	1922
United States	239,333	125,454	169,441	31,715	128,453
Canada	6,679	4,593	10,192	5,025	4,085
Great Britain	54,357	37,452	55,561	23,508	33,878
Spain	350	280	416	176	(a)
France	(a)	4,894	9,000	(a)	(a)
Italy	876	900	810	1,600	1,700
Norway	155	560	.....	.....	.....
Australia:					
New South Wales	2,315	2,046	1,213	.....	(a)
Queensland	.....	.....	613	545	(a)
Victoria	102	319	13	199	(a)
Bavaria	6,011	6,396	6,272	(a)	(a)
Saxony	2,332	2,906	2,918	4,763	(a)

a Figures not yet available.

CRYOLITE.

Cryolite occurs in commercial quantities only in Greenland, at Ivigtut. The cryolite, according to Ball,[2] is mined in a great open cut, the vertical walls of which stand remarkably well. Air drills are used, and the cryolite is shot with black powder down in benches from the top, the effort being to shatter the product as little as possible. It is then hand cobbed and thrown into wheelbarrows, the waste being separated from fairly pure cryolite in the process. The cryolite is then wheeled to sorting platforms, where several men scoop water over it and others hammer off impurities and sort it by hand. Three classes of ore are thus produced—one for America, the "black" (dark brownish-gray translucent) cryolite, which is approximately 93 per cent cryolite, and two for Denmark, both of white cryolite said to be 95 and 99 per cent pure. The ore is then trammed to a hoist and after hoisting is trammed to the pier and placed in large, carefully alined, straight-walled piles according to its grade.

Formerly two-thirds of the product was sold to the Pennsylvania Salt Co. and the other third went to Copenhagen, but at present these relative proportions are reversed. Of the cryolite shipped to the United States the greater part is now used as a flux in the metallurgy of aluminum and for opaque glass. In aluminum metallurgy in this country the mineral is rapidly being supplanted by artificial cryolite.

The imports of cryolite into the United States in 1922, according to the Bureau of Foreign and Domestic Commerce, amounted to 3,899 long tons, valued at $196,302, or $50.35 a ton, as compared with 3,460 long tons, valued at $295,186, or $85.31 a ton, in 1921.

[2] Ball, S. H., The mineral resources of Greenland: Econ. Geology, vol. 17, pp. 17–31, 1922.

SALT, BROMINE, AND CALCIUM CHLORIDE.

By K. W. Cottrell.

SALT.

PRODUCTION.

Salt producers of the Western and Middle Western States reported conditions generally improved during 1922. In the West there was a greater demand for common coarse salt for use in water-purifying plants, chemical works, and other manufacturing plants, also for curing fish. In the East unfavorable weather, coal strikes, labor shortage, and scarcity of cars tended to increase the cost of operations, and the receipts were lower.

The salt sold in the United States in 1922 showed a general increase of 36 per cent in quantity but only 12 per cent in value.

Salt sold in the United States, 1917–1922.

Year.	Short tons.				Value.[a]	
	Manufactured (evaporated).	In brine.	Rock salt.	Total.	Total.	Average.
1917	2,482,564	2,890,588	1,605,025	6,978,177	$19,940,442	$2.86
1918	2,724,203	2,830,600	1,683,941	7,238,744	26,940,361	3.72
1919	2,392,290	2,850,639	1,639,973	6,882,902	27,074,694	3.93
1920	2,409,924	2,819,916	1,610,189	6,840,029	29,894,075	4.37
1921	1,931,243	1,577,335	1,472,576	4,981,154	24,557,966	4.93
1922	2,276,683	2,569,042	1,947,124	6,792,849	27,464,838	4.04

[a] The values are f. o. b. mine or refinery and do not include cost of cooperage or containers.

Increase in both quantity and value was shown in seven of the salt-producing States—Ohio, 48 per cent in quantity and 14 per cent in value; Michigan, 40 per cent in quantity and 17 per cent in value; New York, 35 per cent in quantity and 9 per cent in value; California, 33 per cent in quantity and 16 per cent in value; and Kansas, 14 per cent in quantity and 18 per cent in value. Idaho reported no production in 1921, but a small quantity in 1922. Porto Rico, Texas, Virginia, and West Virginia reported decreases in both quantity and value in 1922. The leading State in the production of salt was Michigan, with New York a close second and Ohio, Kansas, and Louisiana following in the order named. The number of operating plants in California and Michigan was 21 each, Kansas 11, New York 14, and Ohio 6. The other States had from 1 to 6 plants each, making a total of 95 active plants, 5 more than in 1921.

Salt produced and sold in the United States, 1919–1922, by States.

State.	1919		1920		1921		1922	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
California	200,115	$1,555,596	212,008	$1,301,426	193,618	$1,043,912	257,790	$1,211,197
Idaho	39	530	(a)	(a)	.....	.....	21	240
Kansas	773,576	4,497,247	783,655	3,839,409	665,968	3,268,661	759,459	3,849,427
Louisiana	(a)	(a)	265,085	1,517,414	(a)	(a)	336,852	1,657,708
Michigan	2,492,378	9,456,138	2,262,915	10,698,674	1,427,465	7,439,445	2,005,088	8,693,604
New Mexico	(a)	(a)	(?)	(a)	(a)	(a)	718	5,747
New York	1,947,829	7,159,547	1,903,101	7,584,921	1,455,014	6,505,041	1,960,867	7,066,409
Ohio	991,730	2,362,941	1,057,802	3,324,492	749,349	3,284,952	1,105,757	3,749,564
Porto Rico	(a)	(a)	.....	.....	7,418	24,908	(a)	(a)
Texas	(a)	(a)	91,103	667,835	(a)	(a)	(a)	(a)
Utah	77,336	432,130	75,259	546,186	68,874	491,354	81,909	387,093
West Virginia	18,599	167,529	29,802	348,556	27,964	320,537	25,188	283,257
Undistributed [b]	381,300	1,443,036	159,299	65,162	385,484	2,179,156	259,200	560,592
	6,882,902	27,074,694	6,840,029	29,894,075	4,981,154	24,557,966	6,792,849	27,464,838

[a] Included under "Undistributed."
[b] 1919: Hawaii, Louisiana, Nevada, New Mexico, Porto Rico, Texas, and Virginia: 1920: Hawaii, Idaho, Nevada, New Mexico, and Virginia; 1921: Hawaii, Louisiana, New Mexico, Texas, and Virginia. 1922: Porto Rico, Texas, and Virginia.

Comparison with figures for 1921 shows an increase in quantity for every variety of salt manufactured and an increase in total value for every variety except solar evaporated. The average price received per ton was less in 1922.

Salt sold in the United States in 1922, classified by method of manufacture.

Method of manufacture.	Short tons.	Value.	
		Total.	Average.
Evaporated in open pans or grainers	831,833	$8,224,391	$9.89
Evaporated in vacuum pans	996,843	7,774,876	7.80
Solar evaporated	313,918	1,164,237	3.71
Pressed blocks from evaporated salt	134,089	1,309,255	9.76
Rock	1,908,531	7,244,470	3.80
Pressed blocks from rock salt	38,593	245,174	6.35
Salt in brine (sold or used as such)	2,569,042	1,502,435	.58
	6,792,849	27,464,838	4.04

Rock salt was reported by 20 plants in 8 States. New York led in the production, its output being more than double that of Kansas and almost three times that of Louisiana.

Rock salt sold in the United States, 1917–1922.

Year.	Short tons.	Value.	
		Total.	Average.
1917	1,605,025	$3,897,595	$2.43
1918	1,683,941	5,684,661	3.38
1919	1,639,973	6,224,920	3.80
1920	[a] 1,610,189	[a] 7,048,315	4.38
1921	[a] 1,472,576	[a] 6,693,923	4.55
1922	[a] 1,947,124	[a] 7,489,644	3.85

[a] Includes pressed blocks made of rock salt, as follows: 1920, 15,182 tons, valued at $172,211; 1921, 20,148 tons, valued at $169,244; 1922, 38,593 tons, valued at $245,174.

Evaporated salt sold in the United States in 1921 and 1922, by States.

State.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
California	178,118	$962,412	249,483	$1,169,662
Kansas	251,769	2,407,642	302,700	2,651,598
Michigan	706,218	6,279,781	845,667	7,383,596
New York	367,119	3,016,855	418,498	3,128,918
Ohio	249,349	2,784,952	278,870	2,913,363
Porto Rico	7,418	24,908	(a)	(a)
Utah	64,401	468,461	77,625	368,543
West Virginia	27,964	320,537	25,188	283,257
Undistributed [b]	78,887	581,415	78,652	573,822
	1,931,243	16,846,963	2,276,683	18,472,759
Percentage of decrease in 1921 and of increase in 1922.	−19.9	−19.8	+17.9	+9.7

[a] Included under "Undistributed."
[b] 1921: Hawaii, New Mexico, and Texas; 1922: Idaho, Louisiana, Porto Rico, and Texas.

The production of pressed blocks in the last six years as reported by the original producers of the salt and shown in the following table does not represent the entire pressed-block industry, because some firms that do not produce salt are making pressed blocks of salt bought in the open market:

Pressed salt blocks sold in the United States, 1917–1922.

Year.	Short tons.	Value.		Year.	Short tons.	Value.	
		Total.	Average.			Total.	Average.
1917	64,380	$457,273	$7.10	1920	129,224	$1,515,041	$11.72
1918	94,150	939,900	9.98	1921	117,739	1,275,483	10.83
1919	119,510	1,358,757	11.37	1922	172,682	1,554,429	9.00

CONSUMPTION.

Of the total consumption of salt in 1922 in the United States 98 per cent was of domestic production and only 2 per cent was imported.

Supply of salt for domestic consumption, 1918–1922, in short tons.

Source.	1918	1919	1920	1921	1922
Domestic production	7,238,744	6,882,902	6,840,029	4,981,154	6,792,849
Imports	40,290	59,514	137,654	93,095	111,710
	7,279,034	6,942,416	6,977,683	5,074,249	6,904,559
Exports	136,783	119,416	139,272	109,563	134,989
Domestic consumption	7,142,251	6,823,000	6,838,411	4,964,686	6,769,570
Comparison with preceding year	+213,145	−319,251	+15,411	−1,873,725	+1,804,884
Percentage of imports to total consumption.	0.6	0.9	2.0	1.9	1.7

IMPORTS AND EXPORTS.

According to figures obtained from the Bureau of Foreign and Domestic Commerce, Department of Commerce, and converted from pounds, as reported by that bureau, to short tons, the salt imported and entered for consumption in the United States in the last six years has been as follows:

Salt imported and entered for consumption in the United States, 1917–1922.

Year.	In bags, barrels, and other packages.		In bulk.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1917	13,472	$139,339	51,450	$140,796	64,922	$280,135
1918	10,259	148,128	30,031	133,340	40,290	281,468
1919	9,676	137,627	49,838	105,077	59,514	242,704
1920	29,567	240,923	108,087	435,576	137,654	676,499
1921	38,374	333,282	54,721	197,749	93,095	531,031
1922	[a] 22,180	[a] 211,714	89,530	305,620	111,710	517,334

[a] Includes 40 short tons, valued at $545, imported for curing fish.

Salt imported into the United States, 1919–1922, by countries.

[General imports.]

Country.	1919		1920		1921		1922	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
France	56,000	$601						
Germany	6,613,800	81,698	47,669,300	$143,158	82,712,700	$250,614	110,656,000	$274,511
Italy					5,846,400	8,347		
Netherlands			314,700	294				
Portugal	22,100	242	17,008,000	34,624	2,912,000	2,850		
Spain	55,722,100	37,952	65,732,100	71,158	12,494,400	29,597	25,552,600	27,047
England	18,401,200	139,408	44,281,500	236,374	16,676,700	123,999	14,104,100	105,172
Scotland			200	1				
Canada	299,700	3,050	3,156,200	22,188	1,692,000	13,560	1,889,300	14,547
Newfoundland and Labrador							115,000	2,800
Panama		1						
Mexico	79,700	637			18,200	142		
Jamaica							1,034,100	1,379
Trinidad and Tobago							3,265,400	3,668
Other British West Indies	41,930,900	55,423	74,961,600	124,654	35,761,400	54,271	59,731,400	77,966
Dutch West Indies	2,139,300	4,633	20,415,600	39,571	9,603,200	12,425	11,016,100	15,713
French West Indies			1,106,200	2,868	62,000	151		
Virgin Islands of the United States	374,600	725			902,800	1,788		
Argentina			228,400	1,142				
Chile							17,300	99
Venezuela			75,600	137				
Japan	1,500	12	300	4	500	19	3,000	24
Hongkong	200	5	100	17	1,100	11		
Turkey in Asia					700	6		
Australia	1,100	15						
Canary Islands			358,400	309				
French Africa					17,506,000	33,251		
Portuguese Africa							243,200	110
	125,642,200	324,402	275,308,200	676,499	186,190,100	531,031	227,627,500	523,036

Salt exported from the United States, 1917–1922.

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1917	113,993	$1,000,773	1920	139,272	$1,901,593
1918	136,783	1,677,577	1921	109,563	1,415,471
1919	119,416	1,396,625	1922	134,989	1,429,172

Salt exported from the United States, 1920–1922, by countries.

Country.	1920		1921		1922	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Europe:						
Belgium	600	$16				
Denmark	4,800	150				
Esthonia					300	$10
France	38,140	3,654	1,344	$48		
Germany	2,051	30			138	4
Greece	112	2			8,800	89
Iceland and Faroe Islands	2,000	77	2,400	95	3,700	115
Latvia					672	17
Netherlands					2,500	79
Poland and Danzig	395	19				
Rumania	274	17			700	15
Russia in Europe	6,000	96	3,380	44	9,924	127
Spain	92	8			2,240	11
Sweden	778,748	14,366				
Turkey in Europe	4,720	118				
United Kingdom—England	227,600	1,226	10,000	150	3,969	114
North America:						
Bermuda	138,221	1,697	128,284	2,128	182,100	2,130
British Honduras	300,285	3,404	262,212	2,813	378,984	3,833
Canada	182,799,386	959,451	163,278,742	908,753	208,495,592	928,477
Central American States:						
Costa Rica	438,134	4,995	59,380	1,145	200,676	1,658
Guatemala	132,098	2,219	128,559	2,182	891,415	5,373
Honduras	2,641,512	23,022	1,859,679	23,202	2,377,529	21,294
Nicaragua	566,838	8,908	451,557	8,046	537,263	7,611
Panama	3,137,777	36,457	2,236,694	24,069	1,403,816	13,522
Salvador	2,000	60	1,821	82	792	54
Mexico	10,647,691	130,022	9,305,018	113,261	9,562,151	94,964
Miquelon, Langley, etc	1,520	42	576	11	1,500	40
Newfoundland and Labrador	879,888	7,660	603,490	5,582	112,200	554
West Indies:						
Barbados	1,450	26	724	25		
Jamaica	78,503	1,405	196,438	1,392	4,436	88
Trinidad and Tobago	15,908	445	6,098	244	24	3
Other British	10,551	330			37,369	421
Cuba	62,569,363	519,224	30,965,628	234,577	41,443,389	268,463
Dominican Republic	348,192	7,151	426,830	7,083	186,315	4,621
Dutch West Indies			50	5	96	5
French West Indies	8,539	367	8,500	320	4,396	122
Haiti	12,804	529	8,422	292	4,678	197
Virgin Islands of the United States	10,080	228	12,341	261	4,716	76
South America:						
Argentina	143,035	4,504	20,730	283	275	14
Bolivia	1,575	13				
Brazil	3,831	217	528,136	11,130	70	11
Chile	20,386	647			1,460	63
Colombia	75,933	1,244	55,242	770	80,150	1,348
Ecuador	1,700	22			202	12
Guiana:						
British	9,739	373	280	4		
Dutch	13,500	215	1,500	60		
French	11,112	344				
Peru	1,920	60			6,560	40
Uruguay	54	2				
Venezuela	1,049	20	1,440	29	2,428	36
Asia:						
Armenia and Kurdistan					785	37
China	46,488	3,097	22,093	1,996	29,759	2,344
Kwangtung, leased territory	4,400	425	504	36	112	12
Ceylon					1,160	125
Chosen	6,802	192	7,147	425	4,448	130
East Indies:						
British—						
British India	6,169	634	6,900	463	5,121	242
Straits Settlements	1,458	148	1,234	126	2,387	255
Other British	2,776	207	3,920	238		
Dutch	16,134	1,407	4,213	262		
French	120	14				
Far Eastern Republic			3,240	280	7,488	264
Hongkong	15,569	1,049	90,574	3,646	36,853	2,232
Japan	8,571,850	66,622	6,708,380	28,448	496,750	1,944
Java and Madura					5,736	556
Palestine and Syria					480	47
Russia in Asia	96,529	3,279	10,810	278	2,100	115
Siam	3,044	196	1,065	105	1,359	147
Turkey in Asia	176	12	872	48		

Salt exported from the United States, 1920–1922, by countries—Continued.

Country.	1920		1921		1922	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Oceania:						
Australia	1,155,704	$29,652	900,918	$17,317	2,530,774	$44,137
British Oceania	24,949	679	14,240	345	17,170	316
French Oceania	295,672	4,111	217,218	2,169	230,601	2,236
New Zealand	1,932,538	43,065	486,898	8,261	444,488	9,157
Other Oceania	13,430	280	4,446	103	.....	.....
Philippines	252,593	11,256	72,157	2,734	185,244	8,989
Africa:						
Belgian Congo	3,143	95	2,420	66	21,000	268
British Africa—						
West	2,274	28	265	7	214	8
South	100	2	.....	.....	.....	.....
East	700	21	.....	.....	.....	.....
Canary Islands	96	4	.....	.....	.....	.....
Liberia	302	14	23	1	.....	.....
Portuguese Africa	1,216	22	1,215	31	.....	.....
	278,544,338	1,901,593	219,126,247	1,415,471	269,977,554	1,429,172

BROMINE.

The bromine sold in 1922 was 41 per cent greater in quantity but 13 per cent less in value than in 1921. The average price decreased 38 per cent. A large part of the output is not sold as bromine but in the form of potassium and sodium bromides and other salts. The figures given in the following table include the bromine content of these salts. The values given in the table are reported to the Geological Survey by the producers and represent averages for the year f. o. b. at the plants.

The wholesale price per pound of bulk bromine as quoted in 1922, according to Chemical and Metallurgical Engineering, ranged downward from 24 to 21 cents in January, stood at 20 to 21 cents from February 1 until about the middle of March, then increased to 27 to 28 cents and remained at that level until the end of the year.

Bromine had not been imported into the United States for several years prior to 1921, when imports of 300 pounds, valued at $84, were reported. For 1922 the imports reported were 1,094 pounds, valued at $339. The exports of bromine are not separately reported by the Bureau of Foreign and Domestic Commerce.

Bromine sold in the United States, 1911–1922.

Year.	Pounds.	Value.		Year.	Pounds.	Value.	
		Total.	Average.			Total.	Average.
1911	651,541	$110,902	$0.17	1917	895,499	$492,703	$0.55
1912	647,200	145,805	.22	1918	1,727,156	970,099	.56
1913	572,400	115,436	.20	1919	1,854,971	1,234,969	.67
1914	576,991	203,094	.35	1920	1,160,584	745,381	.64
1915	855,857	856,307	1.00	1921	711,953	172,759	.24
1916	728,520	951,932	1.31	1922	1,005,174	150,668	.15

CALCIUM CHLORIDE.

The calcium chloride reported in the following table is an original constituent of the natural brine produced in connection with the manufacture of salt and bromine in California, Michigan, Ohio, and West Virginia. These statistics cover the direct production of calcium chloride from mineral raw materials only. A further large output made by manufacturing processes used in the chemical industries is not reported.

Calcium-magnesium chloride from natural brines produced and sold in the United States, 1911–1922.

Year.	Short tons.	Value.		Year.	Short tons.	Value.	
		Total.	Average.			Total.	Average.
1911	14,606	$91,215	$6.25	1917	30,503	$451,480	$14.80
1912	18,550	117,272	6.32	1918	26,624	503,452	18.91
1913	19,611	130,030	6.63	1919	26,123	321,596	12.31
1914	19,403	121,766	6.28	1920	27,849	539,471	19.37
1915	20,535	130,830	6.37	1921	23,672	510,723	21.57
1916	27,709	224,997	8.12	1922	33,067	571,326	17.28

ASBESTOS.

By Edward Sampson.[1]

PRODUCTION.

The year 1922 was disastrous for the domestic asbestos-mining industry. Prices of the longer grades of chrysotile continued to fall, with the result that profitable mining in the Arizona field became impossible. In 1920 the sales of chrysotile had reached 1,245 tons, valued at $661,907. This was by far the greatest value ever attained. In 1921 mining fell off greatly, and in 1922 only 25 tons, valued at $3,320, reached the market.

Domestic asbestos sold in the United States, 1918–1922.

Year.	Chrysotile.		Amphibole.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1918	392	$101,059	606	$17,628	998	$118,687
1919	502	229,265	659	19,000	1,161	248,265
1920	1,245	661,907	403	16,324	1,648	678,231
1921	438	313,268	393	23,700	831	336,968
1922	25	3,320	42	6,800	67	10,120

A detailed analysis of the production as given for 1921 is not possible for 1922 without revealing confidential information.

A description of the mineralogic character and geologic occurrence of the several varieties of asbestos was published in the asbestos report for 1920.

REVIEW BY STATES.

Arizona.—Asbestos mining in Arizona was largely suspended in 1922 except for necessary assessment work. The two largest mines of the region were inactive throughout the year. The Arizona Asbestos Association (Johns-Manville) suspended operations at Chrysotile. The American Ores Asbestos Co. dismantled the surface equipment of its mine in the Sierra Ancha and abandoned the property. The deposit is reported to be worked out. At the Regal mine operations were suspended awaiting an improvement of market conditions. The sales of asbestos from the field may not be disclosed, but the total amount mined in Arizona, all crude fiber, was as follows: No. 1, 20.5 tons; No. 2, 43 tons; No. 3, 29 tons; total, 92.5

[1] The domestic statistics have been prepared by Miss B. H. Stoddard, of the Geological Survey; the figures on imports by J. A. Dorsey, of the Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce; and the tables on foreign production from data collected by Miss W. I. Whiteside, of the Geological Survey.

tons. Only a small part of this was sold. The list of those contributing to this output follows:

Producers of asbestos in Arizona field, 1922.

Name.	Address.	Location of property.
Great View Asbestos Co.	Care A. J. Dunaway, P. O. Box 47, Miami, Ariz.	San Carlos Indian Reservation, near "the Peninsula," on Salt River.
Kyle & Casliot	Care Roger Kyle, B. P. O. Elks, Globe, Ariz.	4 miles from Chrysotile, near "Salt Bank."
Penn Asbestos Mines Co.	North Wales, Pa	Adjacent to boundary line of San Carlos Indian Reservation, overlooking "the Peninsula," on Salt River.
Riga Asbestos Co	Care C. A. Watkins, P. O. Box 194, Globe, Ariz.	On Wilson Creek about 7 miles from "Rock House."
San Carlos Asbestos Mining Co.	Care Chas. A. Johnson, Lakeside, Ariz.	Adjoins north side of Great View property.
Triangle Asbestos Co	Care J. W. Fulton, Young, Ariz	At confluence of Walnut and Cherry creeks.

For the last three years stocks of Arizona asbestos have been accumulating owing to the continuously falling price of Canadian "crudes." At the time of writing it appears probable that prices will rise in the near future. (For a more detailed analysis see "Prices," p. 33.) One of the difficult problems in the marketing of Arizona asbestos is establishing contact between the buyer and the small producer who is remotely situated.

To assist in this contact the Survey has made a canvass of the stocks of Arizona "crude" other than that held for consumption by Johns-Manville. The stocks available on May 22, 1923, were as follows: No. 1, 77¾ tons; No. 2, 194½ tons; No. 3, 40 tons; total, 312¼ tons. These stocks are in lots ranging from three-fourths of a ton to 130 tons. The Survey will place prospective buyers in communication with those who may be able to fill their needs.

In 1922 there was much activity in acquiring title to asbestos land in the Fort Apache and San Carlos Indian reservations. The state of affairs on January 1, 1923, may be summed up as follows:

Leases granted and applications approved for asbestos claims in Arizona Indian reservations up to January 1, 1923.

Leases granted.

Name of property.	Owners.	Location.
Fort Apache Reservation:		
Kerrick group	W. G. Shanley et al	North side of Salt River canyon, apparently about opposite Regal mine.
Snake Hill group	do	North side of Salt River canyon, ½ mile in air line northwest of mouth of Sawmill Creek.
San Carlos Reservation:		
Accident group	McD. Robinson et al	On Cienega Creek and contiguous to reservation boundary, between 19½ and 20 mile monuments.
Blue Mule and Rex groups.	Apache Asbestos Co	Bear Creek (Bear Canyon).
Great View group	J. B. Cobb, G. P. Bartlett, et al.	South side of Salt River canyon, 1½ miles S. 81° E. from 20½-mile monument of San Carlos Reservation boundary.
Horse Shoe group	L. R. Jacobsen et al	North side of Salt River canyon on trail north from "the Peninsula" and high above river.
Penn group	Apache Asbestos Co	South side of Salt River canyon, ¾ mile N. 76° E. from 20-mile monument of San Carlos Reservation boundary.
Silk claim	W. M. Malone	At mouth of Sawmill Creek.
Squirrel group	San Carlos Asbestos Mining Co.	Adjoins Great View group on east and south.
Wonder claim	J. E. Malone	Adjoins Silk claim at mouth of Sawmill Creek.

Leases granted and applications approved for asbestos claims in Arizona Indian reservations up to January 1, 1923—Continued.

Applications approved.

Name of property.	Owners.	Location.
Fort Apache Reservation:		
Apache group	E. D. Reidhead	1 mile above Cibique Creek where Salt River flows north and 300 yards north of Salt River.
Bluff and Cyax groups.	J. Hansen, Arch Penrod, and Eph Penrod.	About ¾ mile southeast of Horse Shoe group.
Devil's Trail group	A. K. Miller, Willard Whipple, jr., et al.	Adjoins Horse Shoe group on southeast.
Gun Sight group	H. S. Colcord and Wesley Goswick.	1½ miles east of Cibique Creek and 1 mile north of Salt River.
Last Chance group	E. D. Reidhead and M. V. Reidhead.	Side line 500 feet northeast of northeast corner of Snake Hill group.
Sun group	Apache Asbestos Co.	West side of Salt River draw about 2 miles north of Salt River.
San Carlos Reservation:		
Falls group	McD. Robinson et al	½ mile east of reservation boundary from about 19½ nearly to 20½ mile monuments; lies between Accident and Penn groups.
Seneca group	do	1¾ miles S. 81° E. from 19-mile monument.
Sunset group	Chas. A. Johnson, Frank Wren, and Niels S. Hansen.	Along Salt River 1½ to 2 miles east of reservation boundary; adjacent to north side of Squirrel group.

California.—Walter R. Harris and J. E. Barrett, of Bryson, report active prospecting and development at the Burro Gorge asbestos mine, near Jolon, in Monterey County. The California Asbestos Mining Co., whose property is on Clear Creek, near Coalinga, in San Benito County, and the Pacific Asbestos Corporation, whose property is near Copperopolis, in Calaveras County, both continued surface developments, which have been under way for three years. Neither company has yet shipped any fiber. The Sierra Asbestos Co. suspended mining operations but constructed a reservoir and pipe line to furnish water power to its mill. A consumer in San Francisco reports that a shipment of amphibole asbestos was obtained from the Sims district, in Shasta County.

Georgia.—A noteworthy event of the year was the suspension of operations in Georgia by the Sall Mountain Co. This company has mined mass-fiber anthophyllite for many years.

Maryland.—The Powhatan Mining Co. continued to prepare a high-grade filter fiber from slip-fiber anthophyllite.

Oregon.—A deposit of very soft, long tremolite, described as occurring in strong veins in a serpentinized dike, has been located by L. B. Larson near Hereford, Oreg. This material appears to be suitable for chemical filters and is worthy of investigation by anyone requiring such material.

Vermont.—The Asbestos Corporation of America continued active construction in 1922 and made a small first shipment. The company is now being reorganized.

PRICES.

The prices of Canadian chrysotile asbestos, which control domestic prices, are shown in Figure 2. These curves are based on a balanced average of the weekly quotations of the Engineering and Mining Journal-Press. On this graph the forms of the curves are strictly comparable. Like variations are shown by similar curves,

whether for the highest grade or for the lowest—in other words, where the slopes of the curves are the same the proportionate change in price has been the same. For example, if the price of "crude" No. 1 dropped one-quarter and if the price of shingle stock dropped one-quarter in the same interval of time, the slopes of the curves representing this change would be the same. The sharp rise in prices culminating in June was due to a shortage, particularly of the shorter grades. The increased activity at the mines as favorable weather came soon induced a reduction that brought the price into line with

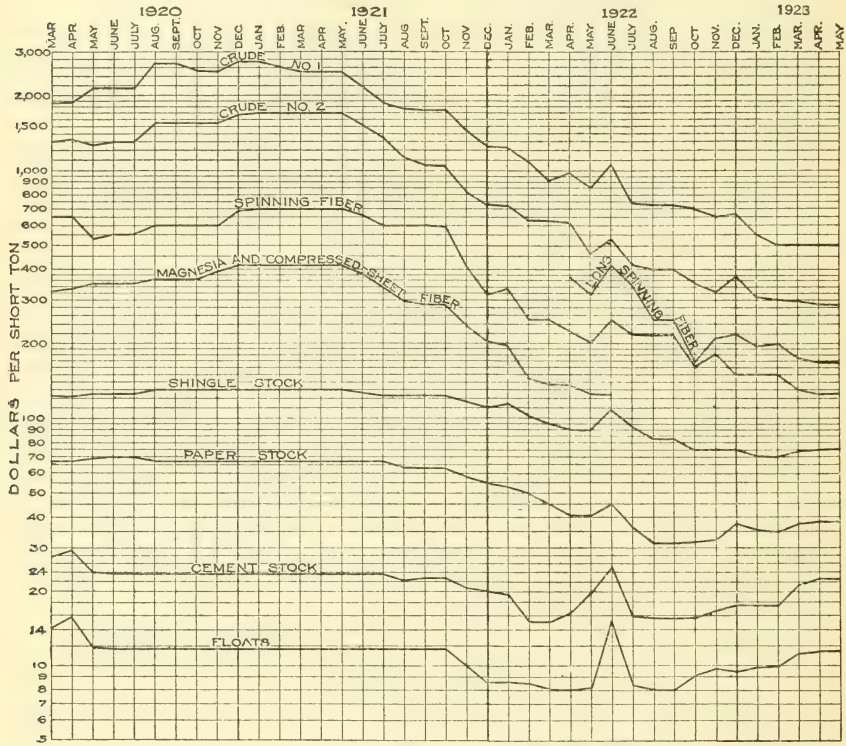

FIGURE 2.—Prices of Canadian asbestos "crude" and "fiber."

the regular trend. Toward the end of the year competition between Canadian and South African "crudes" became particularly keen, Canadian "crudes" having to compete with Rhodesian chrysotile, and the longer grades of mill fiber having to compete with Cape crocidolite, which is finding an increasing use in pipe covering, in bituminous compounds, where a longer though weaker fiber of crocidolite can be obtained for the same price as chrysotile and for chemical filters, the crocidolite being said to withstand acid better than chrysotile. This trend of prices continued into 1923, the decreases in the prices of longer grades being offset by the increases in the short grades on which such competition does not exist.

IMPORTS AND EXPORTS.

The imports of asbestos, as shown in the following table, returned to normal in 1922 and showed an increase of 106 per cent in quantity and 74 per cent in value over those of 1921.

General imports of asbestos (unmanufactured), 1918–1922, in short tons.

Source.	1918	1919	1920	1921	1922	
					Quantity.	Value.
Australia			3	1	8	$7,051
British India		1				
British South Africa	837	900	2,233	504	411	59,817
Canada	134,813	133,662	162,717	71,412	147,596	4,745,296
Chile				1		
China		1	17	50	(a)	128
Colombia	1					
England		156	746	200	1,273	299,358
France		450				
Germany				11	(a)	2
Greece			81			
Hongkong				1		
Italy			3	2	1	40
Japan			100	1		
Portuguese Africa	2,049	100	1,584	279	138	33,008
Trinidad and Tobago				1		
Turkey in Asia			74			
Total value	137,700 $6,337,585	135,270 $7,369,685	167,558 $9,120,253	72,463 $2,948,302	149,427	5,144,700

(a) Less than 1 ton.

In the foregoing table the countries given as the sources are merely the countries from which asbestos was last shipped as shown by the invoices or manifests from which the records of imports were compiled. It is probable that Rhodesia and the Union of South Africa were the actual source of all imports except those credited to Canada and Italy.

The exports of unmanufactured asbestos in 1922 were 376 short tons, valued at $49,939. The exports of manufactured asbestos were as follows:

Manufactured asbestos products exported from the United States in 1922.

Grade.	Quantity.	Value.
Paper, millboard and roll board ..... short tons	1,149	$122,746
Pipe covering and cement ..... do	1,709	224,352
Textile yarn and packing ..... do	334	492,422
Magnesia pipe and boiler covering ..... do	1,916	223,686
Asbestos roofing ..... square feet	5,243,988	182,895
Other manufactures, except roofing ..... short tons	1,583	658,227

WORLD'S PRODUCTION.

World's production of asbestos, 1918–1922, by countries, in metric tons.

Country.	1918	1919	1920	1921	1922
Australia:					
New South Wales[a]	.....	145	675	960	(b)
South Australia[c]	.....	.....	5	2	(b)
Tasmania[d]	2,900	52	.....	.....	(b)
Western Australia[e]	.....	54	159	239	(b)
British South Africa:					
Rhodesia[f]	7,778	8,889	17,076	17,716	12,926
Union[g]	3,333	3,567	6,452	4,646	3,785
Canada[h]	128,331	124,070	162,038	84,151	160,339
China[i]	243	69	5	13	(b)
Chosen[j]	.....	132	(b)	(b)	(b)
Cyprus[k]	232	1,352	911	(b)	(b)
Germany[l]	(b)	12	28	(b)	(b)
India[m]	363	394	1,847	321	(b)
Italy[n]	60	98	165	420	500
New Zealand[o]	.....	.....	2	(q)	(b)
Philippine Islands[p]	70	375	.....	.....	(b)
Russia[r]	(b)	(b)	1,478	2,604	2,102
Spain[s]	.....	.....	.....	19	(b)
United States	905	1,053	1,495	754	61
	144,215	140,262	192,336	t 112,800	t 181,000

[a] New South Wales Dept. Mines Repts.
[b] Figures not yet available.
[c] South Australia Dept. Mines, Review of mining operations.
[d] Tasmania Secretary Mines Repts.
[e] Western Australia Secretary Mines Repts.
[f] Southern Rhodesia Secretary Mines Ann. Repts.
[g] Union of South Africa Secretary Mines, etc., 1918–1921, Ann. Repts.; 1922, Monthly Repts. of mineral production.
[h] 1918–1920, Canada, Dept. Mines, Mines Branch, Ann. Repts. of mineral production. 1921, Dominion Bureau of Statistics. 1922, Quebec Bur. Mines, revised preliminary figures, letter to Oliver Bowles, U. S. Bur. Mines.
[i] 1918–19, U. S. Dept. Commerce, Commerce Rept. 77, Apr. 1, 1920. Figures in table above in part estimated from values. 1920–21, Maritime Customs, Foreign trade of China, Exports.
[j] American consul, Tokyo. Data from Japan Dept. Agr. and Commerce, Mining Bur.
[k] Imperial Mineral Resources Bur., The mineral industry of the British Empire and foreign countries—Asbestos, war period (1913–1919), p. 28, 1921. Official figures for 1919–1920 furnished to the American diplomatic agency, Cairo, Egypt.
[l] Glückauf, Jan. 14, 1922.
[m] India Geol. Survey Records.
[n] Rivista del servizio minerario.
[o] New Zealand Dept. Mines.
[p] Philippine Bur. Sci., Div. Mines, Mineral Resources.
[q] Less than 1 ton.
[r] 1920–21, Min. Jour., Apr. 8, 1922. 1922, Imports, Hamburg, Asbestos, vol. 4, No. 9, March, 1923.
[s] Estadística minera de España.
[t] In part estimated. Unaccounted for: 1921, 955 tons; 1922, 1,287 tons.

The great interest shown in South African asbestos warrants a more detailed analysis of the figures. In the following table is given the production of the several States since 1913:

Asbestos shipped from British South Africa, 1913–1922, in metric tons.

	Rhodesia.[a]	Transvaal.[b]	Cape.[b]	Natal.[b]
1913	263	.....	851	22
1914	442	27	1,052	.....
1915	1,823	50	1,890	.....
1916	5,586	369	3,836	19
1917	8,674	2,897	2,721	25
1918	7,778	844	2,485	4
1919	8,889	572	2,906	89
1920	17,076	3,212	3,199	41
1921	17,716	1,445	3,145	56
1922	12,926	1,273	2,507	5

[a] Southern Rhodesia Sec. Mines Ann. Repts.
[b] Union South Africa Sec. Mines, etc., 1913–1921, Ann. Repts.; 1922, Monthly Repts. of mineral production.

It should be noted that the output from Rhodesia is chrysotile; from Transvaal, amosite; from the Cape, crocidolite; and from Natal, probably nearly all tremolite. This table shows the great increase in the output of Rhodesia, where there is now a firmly established industry. The Transvaal material, amosite, is now not marketable in this country but enters other markets. The stability of the Cape crocidolite industry is noteworthy. Crocidolite has also been mined in Bechuanaland, but figures are not available.

Active operations have been resumed in Cyprus on a more extensive scale than ever before. A new mill was built by the Cyprus Asbestos Co. and in April, 1923, was said to be treating 400 tons of fiber a month.[2] The old mill was being remodeled for a capacity of 600 tons a month and was expected soon to be producing at this rate. This would bring the total up to 1,000 tons a month, an output which, if it can be maintained, will be an important factor in the world trade.

[2] Mining Mag. (London), vol. 38, No. 4, p. 258, April, 1923.

NITRATES.

By George Rogers Mansfield.

Nitrates in the United States.—Sodium, potassium, and calcium nitrates are widely distributed in small quantities through many of the Western and Southwestern States. The most promising deposits, those of the Amargosa region, in southeastern California, were studied intensively by members of the United States Geological Survey during the war, and the results of these studies have recently been published.[1] They showed clearly that these deposits, though interesting scientifically, were quantitatively insufficient for commercial development.

The Geological Survey still receives inquiries from time to time regarding nitrate deposits, but no evidence has yet been produced to show that in any of the deposits mentioned by correspondents the nitrate is of more than scientific interest. Although fine specimens or small lots of practically pure nitrate of soda or nitrate of potash have been found at many places the quantity has always proved to be insignificant.

No advance can be recorded in the production of atmospheric nitrogen in the United States for 1922. A comparatively small plant in New York State uses a modification of the Haber process, but its product is in a form not suitable for use as fertilizer. The United States Government has not yet disposed of the Muscle Shoals plant, but work has been resumed on the dam, which is the key feature of the project.

Chile nitrate.—As reported by the Bureau of Foreign and Domestic Commerce, 149,570 long tons more of nitrates were imported into the United States from Chile in 1922 than in 1921, but the imports for 1922 were still far below the average over the last 10 years, as shown in the following table:

Nitrate of soda imported into the United States, 1913–1922, in long tons.

Year.	From Chile.	Total.	Year.	From Chile.	Total.
1913	618,742	625,862	1918	1,843,009	1,845,074
1914	540,200	541,715	1919	391,547	407,459
1915	772,180	772,190	1920	1,297,510	1,321,892
1916	1,213,706	1,218,423	1921	361,711	379,173
1917	1,543,213	1,543,213	1922	511,281	542,464

Much of the material imported into the United States between 1914 and 1919 went to manufacturers of munitions. When the demand from this direction ceased, there were large stocks on hand

[1] Noble, L. F., Mansfield, G. R., and others, Nitrate deposits in the Amargosa region, southeastern California: U. S. Geol. Survey Bull. 724, 1922.

in the United States and at the primary markets. As a result the total shipments to Europe, the United States, and to various other parts of the world dropped tremendously in 1919. In 1920 renewed confidence was evident, and exports from Chile to the United States and Europe tripled. By the end of that year this confidence had weakened, and in 1921 imports of nitrate in Europe and in this country were again greatly reduced. No proper basis has been established on which to estimate the consuming power of Europe and the United States, but it seems probable that for these countries it now exceeds that of the years prior to 1914.[2]

Throughout 1922 considerable dissatisfaction was expressed at the manner in which nitrate of soda is handled in Chile, where a trust backed by the Chilean Government arbitrarily fixes its prices. Consumers contend that had the trust been willing to lower prices more nitrate would have been consumed throughout the world, but there is no evidence that the Chilean Government intends to change its present plan of operations.

Imports of inorganic nitrogen.—Nitrate of soda made up by far the greater portion of the imports of nitrogen compounds into the United States in 1922. Chile furnished practically all of this product. Calcium cyanamid, sulphate of ammonia, calcium nitrate, and part of the sodium nitrate were imported for consumption in the fertilizer industry, the potassium nitrate and the remainder of the sodium nitrate for use in the chemical industries.

Inorganic nitrogen imported and entered for consumption in the United States in 1922.[a]

Compound.	Long tons.	Value.
Sodium nitrate	542,464	$26,152,723
Calcium cyanamid, or lime nitrogen	41,807	2,238,474
Sulphate of ammonia	4,932	262,576
Potassium nitrate (saltpeter), crude	2,438	141,521
Potassium nitrate (saltpeter), refined	358	49,233
Calcium nitrate (nitrate of lime)[b]	1,097	46,508
	593,096	28,891,035

[a] Compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.
[b] Figures cover period Sept. 22 to Dec. 31. Not separately classified prior to new tariff.

[2] Am. Fertilizer Handbook, 1923.

MAGNESIUM AND ITS COMPOUNDS.

By J. M. Hill and G. F. Loughlin.

INTRODUCTION.

For many years magnesite, the normal carbonate of magnesium, and dolomite, or high-magnesium limestone, were the only commercial sources of magnesian products in the United States, and their uses were sufficiently distinct for magnesite to be treated in a separate chapter of Mineral Resources and for dolomite to be included with limestone in the chapter on stone. Domestic magnesite, though a potential source of several products that were marketed chiefly east of Mississippi River, could not compete with foreign magnesite. During the World War, however, domestic magnesite and dolomite were both exploited to relieve the shortage caused by the curtailment of imports. Imports of magnesium chloride and sulphate and of metallic magnesium were also restricted, and this condition has led to the exploitation of domestic deposits and processes of manufacture. For these reasons it has been suggested that the annual review of magnesium and its natural and manufactured compounds be given in one chapter. The natural compounds include magnesite, dolomite, magnesium chloride, and magnesium sulphate. The manufactured compounds include the basic (or "technical") carbonate, calcined and dead-burned magnesite, dead-burned dolomite, and precipitated carbonate and sulphate derived from magnesite or dolomite, or from the crude sulphate.

Only the quantity of dolomite produced for its magnesium content is included here. Much larger quantities, either burned into lime or used as dimension, crushed, or pulverized stone, are included in the corresponding chapters on lime and stone.

The uses to which magnesite has been or may be put, for most of which dolomite is also used, are as follows:[1]

In the manufacture of carbon dioxide and the sulphite process of paper manufacturing, in both of which magnesite has been displaced by cheaper dolomite or limestone; for refractory brick, shapes, crucibles, and furnace hearths, for which both dead-burned magnesite and dead-burned dolomite are used; for medicinal and toilet preparations, which are made from magnesite, dolomite, and natural mag-

[1] These uses are reviewed in detail in U. S. Geol. Survey Bull. 355, 1908, and brief comments on magnesium chloride, sulphate, basic carbonate, metallic magnesium, and their uses are made in the chapter on magnesite in Mineral Resources of the United States for 1914, pp. 573–577.

nesium sulphate; for pipe covering (mixed with asbestos), which in this country is probably all made from dolomite; for oxychloride (Sorel) cement, which is made from a mixture of calcined magnesite and magnesium chloride; as an absorbent in the manufacture of dynamite, a preventive of boiler scale where sulphurous waters are used, an accelerator in the vulcanization of rubber, fused magnesia for insulation at exceedingly high temperatures, and an adulterant of paint, all of which presumably call for calcined magnesite but are relatively unimportant in the consumption of domestic magnesite; and for metallic magnesium, which is made both from calcined magnesite and from magnesium chloride.

The section on magnesite has been prepared by Mr. Hill, and the other sections by Mr. Loughlin.

MAGNESITE.

DOMESTIC PRODUCTION.

The crude magnesite from domestic deposits marketed in the United States during 1922 amounted to 55,790 short tons, valued at $571,745, practically all of which came from deposits in California. This is an increase of 16 per cent in quantity and 12 per cent in value, as compared with the production in 1921. A small quantity of magnesite was mined late in the year at Valley, Wash., and considerable calcined magnesite was shipped from that point from stock mined in previous years. There were 10 producers in California operating in 7 counties of the State in 1922.

Crude magnesite sold or treated in the United States, 1917–1922.

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1917	316,838	$2,899,818	1920	303,767	$2,748,150
1918	231,605	1,812,601	1921	47,904	510,177
1919	156,226	1,248,415	1922	55,790	571,745

During the year 73,290 short tons of magnesite was mined in the United States, but at the end of the year stocks of broken ore remaining at the mines amounted to 18,000 tons. Less than 2,500 tons of dead-burned magnesite was marketed in 1922, and only 1,300 tons of magnesite was sold in crude form, most of which was later calcined. Approximately 90 per cent of all the magnesite marketed in the United States in 1922 was calcined magnesite for plastic purposes.

IMPORTS AND EXPORTS.[2]

Magnesite, not purified, imported into the United States, 1920–1922, in short tons (general imports).

Country.	1920	1921	1922
Australia	38		
Austria	(a)	9,496	
Belgium			50
Canada	6,751	427	973
Czechoslovakia	4,288	213	7,781
England	31	8	59
Germany	799	3,884	20,074
Greece	4,480	4,480	1,120
India, British		28	3,297
Italy	23,727	36,121	94,930
Mexico	560		
Netherlands	917	2,914	5,379
Scotland	213	90	595
Straits Settlements	(a)		
Turkey in Europe	3,952		
Venezuela	2,576	1,120	
	48,332	58,781	134,258

a Less than 1 ton.

Magnesite imported for consumption in the United States, 1918–1922.

Year.	Crude.		Calcined, not purified.	
	Short tons.	Value.	Short tons.	Value.
1918	5,432	$103,233	19,049	$824,022
1919	6,381	103,311	9,471	270,721
1920	33,550	406,204	14,780	373,165
1921	51,993	525,452	6,788	250,932
1922	73,331	976,283	72,265	1,267,622

Until September 22, 1922, dead-burned magnesite was included in "calcined, not purified." From September 22 to December 31, 1922, imports included 30,200 short tons of dead-burned magnesite, valued at $465,597, and 2,062 short tons of calcined magnesite, valued at $64,309. The ratio of the two products earlier in the year is not known, but the dead-burned magnesite evidently formed the larger share of the imports.

So far as known, Belgium, Germany, and the Netherlands produce no magnesite, the material shipped from those countries originating in Austria and Czechoslovakia. A large part of the magnesite imported from Italy probably comes from Czechoslovakia. With the resumption of activity in the steel industry the imports of magnesite have increased, owing to the fact that a large part of the imported material is dead-burned and is consumed by this industry, which is near the eastern seaboard.

No exports of domestic magnesite were specifically reported during 1922, but 3,831,681 pounds of magnesia pipe and boiler coverings and other manufactures of magnesia, valued at $223,686, were exported. There are no comparable figures for 1921.

[2] Figures of imports and exports compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the U. S. Geological Survey.

CONSUMPTION.

The consumption of magnesite in the United States is equivalent to domestic production plus imports, for there are no exports. The following table shows the relation of domestic and imported crude material in the total consumption by the country. Further comments on consumption are given in a recent article by Stone.[3]

Magnesite (expressed as crude) consumed in the United States, 1917–1922, in short tons.

Year.	Domestic production.	Imports.	Total consumption.	Proportion of consumption supplied by—	
				Domestic magnesite.	Foreign magnesite.
1917	316,838	38,208	355,046	89	11
1918	231,605	43,530	275,135	84	16
1919	156,226	25,321	181,547	86	14
1920	303,767	63,110	366,877	83	17
1921	47,904	65,569	113,473	42	58
1922	55,790	217,861	273,651	26	74

PLASTIC MAGNESITE.

The calcined magnesite produced and marketed during 1922 amounted to 21,990 short tons. As it takes practically 2¼ tons of crude magnesite to make 1 ton of calcined material, this output required 49,480 tons of crude magnesite. Seaton[4] has called attention to the fact that a chemical analysis of calcined magnesite is not sufficient to determine its value, but that samples should also be subjected to a series of physical tests, which he outlines.

The use of calcined magnesite for outside stucco, floors, and interior finish has increased, owing to the development by several producers of what may be termed "standard" material, whose quality can be relied upon. Seaton[5] has given some interesting information concerning the preparation and testing of oxychloride cements and the relation of lime in the utilization of magnesite cements. Riddell and Schuette[6] have given details of the adaptation of quicksilver furnaces to the burning of magnesite at the Maltby plant, near Livermore, Calif., for the production of calcined magnesite.

Eyoub[7] has set forth the results of experiments which indicate that eastern dolomite may be made to yield a satisfactory substitute for caustic calcined magnesite in the manufacture of oxychloride cements.

[3] Stone, R. W., The marketing of magnesite: Eng. and Min. Jour.-Press, vol. 114, No. 5, pp. 191–196, 1922.

[4] Seaton, M. Y. (technical director of Sierra Magnesite Co., Chicago), privately issued paper.

[5] Seaton, M. Y., Plastic calcined magnesite and oxychloride cements: Chem. and Met. Eng., vol. 25, pp. 233–236, 1921. Seaton, M. Y., Hill, C. R., and Stewart, L. C., Action of lime in magnesium oxychloride cements: Idem, pp. 270–274.

[6] Riddell, W. C., and Schuette, C. N., The production of caustic calcined magnesite in the Scott furnace: Eng. and Min. Jour.-Press, vol. 114, pp. 981–984, 1922.

[7] Eyoub, Djevad, Converting dolomite into magnesite: Eng. and Min. Jour., vol. 112, pp. 619–620, 1921.

DEAD-BURNED MAGNESITE.

Only one producer reported the sale of dead-burned magnesite in 1922. This material finds its principal use in the steel industry as a refractory lining for furnaces. A large part of the imported magnesite is used for this purpose, as the market is in the East, and freight rates from western production centers are too high to meet the water rates of foreign material.

MARKET AND PRICES.

Although the market for magnesite during 1922 was considerably better than during 1921, it was not until fall, when it became apparent that the domestic industry would be well protected by the tariff, that marked improvement was evident. In the tariff act of 1922 the following provisions cover magnesite and products made from magnesite:

Schedule 1. Chemicals, oils, and paints.

PAR. 50. Magnesium: Carbonate, precipitated, 1½ cents per pound; chloride, anhydrous, 1 cent per pound; chloride, not specially provided for, five-eighths of 1 cent per pound; sulphate or Epsom salts, one-half of 1 cent per pound; oxide or calcined magnesia, medicinal, 3½ cents per pound; oxide or calcined magnesia not suitable for medicinal use, 3½ cents per pound.

Schedule 2. Earths, earthenware, and glassware.

PAR. 201. * * * magnesite brick, three-fourths of 1 cent per pound and 10 per centum ad valorem.

PAR. 204. (*a*) Crude magnesite, five-sixteenths of 1 cent per pound ($7 per long ton, $6.25 per short ton, $6.89 per metric ton).

(*b*) Caustic calcined magnesite, five-eighths of 1 cent per pound ($14 per long ton, $12.50 per short ton, $13.78 per metric ton).

(*c*) Dead-burned and grain magnesite, not suitable for manufacture into oxychloride cements, twenty-three fortieths of 1 cent per pound ($12.88 per long ton, $11.50 per short ton, $12.67 per metric ton).

Under the old tariff magnesite was free of duty, and there was apparently no duty on imports of Epsom salts or other magnesium chemicals or on magnesite refractory brick. The passage of the new tariff naturally stimulated the domestic industry considerably. Many deposits in California and Washington are being opened up and the plants put in repair for large-scale operations.

Crude magnesite sold for $9.50 to $10.50 a ton throughout most of 1922, though some sales were reported at $12. There is also a small market at a considerable advance for crude magnesite of very high purity for the manufacture of metallic magnesium.

Calcined magnesite for plastic purposes was sold at $30 to $43 a short ton. Most of that sold in 1922 brought about $37 a ton.

Average value per short ton of domestic and imported magnesite, 1918–1922.

Year.	Domestic crude.	Domestic calcined plastic.	Imported crude.	Imported calcined.
1918	$7.83	$32.00	$19.00	$43.26
1919	7.99	32.00	16.19	28.58
1920	9.05	.....	12.11	25.25
1921	10.65	32.00	10.11	36.97
1922	10.25	37.00	13.31	17.54

The following companies in California and Washington are producers of magnesite; most of them sell the calcined products, though some crude can possibly be had from any of them.

California:
- California Magnesite Co., 1215 First National Bank Building, San Francisco.
- W. H. Cone, 409 Call Building, San Francisco.
- A. D. Davenport, Gustine.
- Ferguson & Sinclair, Piedra.
- Hoff Magnesite Co., 333 Monadnock Building, San Francisco.
- A. J. Jackson, jr., Morgan Hill.
- C. S. Maltby, Humboldt Bank Building, San Francisco.
- Regan & Cummings, Chinese Camp.
- Sampson Magnesite Co., 74 New Montgomery Street, San Francisco.
- San Benito Magnesite Co., Hollister.
- Sierra Magnesite Co., 404 Balfour Building, San Francisco.
- White Crown Products Co., 517 Marsh-Strong Building, Los Angeles.

Washington:
- American Mineral Products Co., Valley.
- Northwest Magnesite Co., Crocker Building, San Francisco, Calif.
- Double Eagle Mining Co., Valley.

WORLD'S PRODUCTION.

The following table was compiled by Miss W. I. Whiteside, of the United States Geological Survey:

World's production of magnesite in 1913–1921, by countries, in metric tons.

Country.[a]	1913	1914	1915	1916	1917	1918	1919	1920	1921
Australia:									
New South Wales	7,112	2,032	843	3,821	9,337	3,419	9,413	6,578	12,465
South Australia	.....	.....	81	169	152	447	277	188	175
Victoria	106	23	192	30	75	229	78	153	130
Western Australia	.....	.....	612	100	21	107	.....	.....	.....
Austria-Hungary	[b] 422,439	[b] 279,651	[b] 78,314	[b] 81,771	[b] 106,783	(c)	(d)	[e] 120,347	(f)
British India	16,458	1,707	7,569	17,922	18,493	5,947	17,401	14,577	20,338
Canada	.....	.....	16,475	51,981	58,755	52,434	13,564	28,159	4,521
Greece	98,517	136,701	159,981	199,484	162,938	39,340	62,408	71,870	60,132
Italy	600	1,140	9,200	18,252	31,070	28,882	35,930	33,850	9,410
Norway (exports)[g]	656	938	[b] 4,017	[b] 3,499	[b] 1,004	[b] 542	[b] 1,882	[b] 2,041	[b] 210
Spain	958	583	1,400	2,500	800	1,700	120	1,214	.....
Union of South Africa	403	519	569	553	709	756	929	1,287	1,317
United States (sold or treated)	8,738	10,245	27,668	140,589	287,429	210,107	141,725	275,571	43,458
Venezuela (exports)	(c)	(c)	(c)	6,360	1,700	(c)	(c)	2,000	(c)

[a] In addition to the countries listed, Cyprus produced 14½ tons in 1915 and 15 tons in 1916. Russia's pre-war production is estimated at 15,000 to 20,000 tons; figures of production reported for 1920 and 1921 are 485,000 poods (7,944 metric tons) and 239,000 poods (3,995 metric tons), respectively. Unless otherwise stated, the figures in the table represent crude magnesite mined.

[b] Exports; computed on a basis of 2.1 tons crude to 1 ton sintered.

[c] No data available.

[d] Exports from Austria, second half of 1919, 8,523 tons crude and 24,268 tons dead burned.

[e] Exports from Austria; computed on basis of 2.1 tons crude to 1 ton sintered.

[f] Exports from Austria, first half of 1921, 2,972 tons crude and 36,924 tons dead burned.

[g] In addition there was exported magnesite brick (magnesittegel) as follows: 1913, 626 tons; 1914, 494 tons; 1915, 729 tons; 1916, 519 tons; 1917, 341 tons; 1918, 355 tons; 1919, 357 tons; 1920, 710 tons; 1921, 337 tons.

AUTHORITIES.

Australia: New South Wales, Dept. of Mines, Ann. Repts. South Australia, Review of mining operations, Dept. of Mines. Victoria, Sec. Mines, Ann. Rept. Western Australia, Dept. Mines Rept.

Austria-Hungary: 1913–1917, Imperial Mineral Resources Bureau.

Austria: 1919–1921, Special report by E. Baldwin, assistant trade commissioner, Warsaw, Aug. 31, 1922.

British India: Geol. Survey Rec.

Canada: 1913–1920, Canada Dept. Mines Ann. Rept; 1921, Report on mining operations in the Province of Quebec.

Greece: 1913–1917, 1919–1921, Tableaux statistiques du mouvement minier; 1918, Imperial Mineral Resources Bureau, London.

Italy: Rivista del servizio minerario.

Norway: Norges Handel.

Spain: Estadística minera de España.

Union of South Africa: Sec. Mines, Dept. Mines and Industries, Ann. Rept.

Venezuela: 1916–1917, Imperial Mineral Resources Bureau, London; 1920, consular report, March 15, 1922.

NOTES ON MAGNESITE INDUSTRY.

DOMESTIC INDUSTRY.

California.—During 1922 magnesite was produced in California from deposits near Piedra, Fresno County; Rutherford, Napa County; Sampson, San Benito County; Morgan Hill and Red Mountain, Santa Clara County; Gustine and Patterson, Stanislaus County; Exeter and Porterville, Tulare County; and Chinese Camp, Tuolumne County. The largest output came from the deposits near Red Mountain, operated by C. S. Maltby. The Sierra Magnesite Co. was the second largest producer from its deposits near Porterville. Late in the year the industry was considerably revivified and several of the well-known deposits were put into shape to begin operations and some newly found deposits were opened. Several new operators are beginning production early in 1923. A good summary of conditions in the State was published in the Pacific Mining News for February, 1923. An article by Riddell and Schuette [8] describes the methods of heat control in the Scott quicksilver furnace, which has been installed at Red Mountain by C. S. Maltby for calcining magnesite.

Nevada.—So far as can be learned the magnesite deposits along Muddy River, in Clark County, Nev., were not in operation during 1922. They are the property of the Nevada Magnesite Co. and were described in a press bulletin issued by the United States Geological Survey July 18, 1922, excerpts of which are given below.

A massive deposit of magnesite of unusual character that has recently been brought to the attention of the United States Geological Survey promises to yield a large and readily available supply of this material. The deposit lies in Clark County, Nev., in the valley of Muddy River, one of the tributaries of Virgin River, a few miles above the town of St. Thomas.

The so-called kaolin is stated by the Geological Survey to be in fact a magnesite deposited as a part of a regularly stratified series of sedimentary beds. The deposit forms a chalky-looking bluff, dazzlingly white in the bright sunlight. The material is porcelain-white, fine grained, and massive, is remarkably free from foreign material, and has the structureless appearance and conchoidal fracture that are generally characteristic of magnesite. It is not so hard as the more typical magnesite, and it crumbles more rapidly on exposure to the weather.

The deposit is included between tilted beds of conglomerate and sandstone below and shale above. The purer part of the deposit consists of beds aggregating at least 200 feet in thickness. Within the section of purer material there are a few bands of sandy matter, but these are minor in amount and apparently almost negligible, as they could undoubtedly be avoided in mining.

The two samples of the Muddy River magnesite deposit were taken from exposures in gulches about a mile apart. Sample 1 consisted of cuttings across a clean face and represented 10 feet of material in a section 200 feet thick; the remainder of this section is nearly all of apparently similar material, though a part of it may contain more silica in the form of sand. Sample 2 consisted of similar cuttings from another large exposure, where an even greater thickness of white beds is revealed, the sample representing, however, only about 4 feet in a section of 40 to 50 feet of notably pure white material. The high content of silica in the material from both places is evidently due to grains of sand that formed an original constituent of the deposits. The 5 to 6 per cent of lime shown by the analyses may prove a detriment to some uses of the magnesite.

The series of beds that contains the magnesite is the "Horse Spring formation," of Tertiary age. It contains the colemanite deposits of the Callville district.

[8] The production of caustic calcined magnesite in the Scott furnace: Eng. and Min. Jour.-Press, vol. 114, pp. 981–984, 1922.

Washington.—Although little magnesite was produced from deposits in Washington in 1922, the operators were not inactive. At Valley the American Mineral Products Co. installed a considerable plant for calcining, and at the end of the year it was expected that full operations would be resumed shortly. The Northwest Magnesite Co., at Chewelah, installed a Cottrell treater to prevent dust from going out of its extensive calcining plant. Suits for damages to crops have been instituted against the company by farmers in the vicinity. It was reported [9] late in the year that 350 men would be on the pay roll and that production would be started early in 1923.

It is reported [10] that the Hawkeye Feltstone Co. has recently been incorporated for $60,000 to erect a plant for the manufacture of magnesite products at Mead. This company will get its magnesite from a deposit in Washington near the Canadian border.

A detailed report on the magnesite deposits of the State [11] has recently been issued. Bankson [12] has given a nontechnical account of the operation of the magnesite mines in Stevens County.

Besides the magnesite produced in Washington, magnesium sulphate is produced by a company whose plant is at Oroville.

FOREIGN INDUSTRY.

Because of the important part played by imports, the following notes on foreign magnesite in 1922 are presented:

Austria.—It is said that Germany is now taking more Austrian magnesite than the United States and that a group of German metal firms has recently contracted for the output of caustic magnesite of the Styrian Magnesite Industry Co. A detailed report on the Austrian magnesite industry, as related to the United States market, was made in 1922 by E. Baldwin, American trade commissioner, Warsaw, Poland, and can doubtless be consulted at the offices of the Department of Commerce by those interested.

Canada.—Deposits of magnesite in the Bridge River area of British Columbia were described by W. S. McCann.[13]

Greece.—The magnesite deposits in the serpentine belt of the island of Euboea, on the west coast of Greece, have been described by Boydell.[14] The deposits are operated by Anglo-Greek, Greek, and Dutch interests.

Venezuela.—It is reported that a large body of magnesite has been opened on the island of Margarita, off the Venezuelan coast, by the Magnesite Products Corporation, of New York. An analysis of average material is said to run 48 per cent MgO, 51 per cent CO_2, 0.1 per cent CaO, 0.2 per cent Fe_2O_3, 0.2 per cent SiO_2, and 0.2 per cent Al_2O_3.

[9] Salt Lake Min. Rev., Dec. 15, 1922, p. 25; Feb. 25, 1923, p. 25.
[10] Salt Lake Min. Rev., Feb. 28, 1923, p. 22.
[11] Whitwell, G. E., and Patty, E. N., The magnesite deposits of Washington; their occurrence and technology: Washington Geol. Survey Bull. 25, 1921.
[12] Bankson, R. A., Glory holes and magnesite: Eng. and Min. Jour., vol. 111, pp. 49–52, 1921.
[13] Canada Dept. Mines Mem. 130.
[14] Boydell, H. C., The Euboean magnesite field: Eng. and Min. Jour., vol. 112, pp. 771–776, 1921.

DOLOMITE.

DOLOMITE PRODUCTS.

By far the greatest quantities of dolomite produced in the United States are used for the same general purposes as limestone and are reported as limestone or burned lime. Although it is generally known which companies produce dolomite or high-magnesium limestone, it would be practically impossible to obtain from every producer a complete separation of dolomite from limestone production, and the value of the results would hardly justify the effort. It has been possible, however, to obtain satisfactory information on certain dolomite made into dead-burned dolomite, basic magnesium carbonate, and dolomite used in the sulphite process of paper manufacture and the manufacture of carbon dioxide. The quantity and value of the raw dolomite made into these products are recorded in the annual report on stone. A part of the dead-burned stone, however, has been reported only in terms of the finished product and has therefore been recorded in the chapter on burned lime. The figures are repeated here to complete the information on magnesium compounds.

Dolomite sold for certain uses,[a] 1917–1922.

Year.	Short tons.	Year.	Short tons.
1917	937,000	1920	1,580,000
1918	1,413,000	1921	499,000
1919	947,000	1922	1,074,000

[a] Dead-burned dolomite, basic magnesium carbonate, sulphite process of paper manufacture, carbon dioxide.

DEAD-BURNED DOLOMITE.

The figures given in the above table represent approximately the total dolomite used in industries in which it is known that dolomite rather than limestone is employed. Raw stone for refractory use is reported from California, Colorado, Illinois, Ohio, Pennsylvania, and West Virginia. The dead-burned product is reported from Alabama, New York, Ohio, Pennsylvania, and West Virginia.

Dead-burned or sintered dolomite was produced at a few places before the war for patching furnaces, but it rapidly gained prominence during the war, when imports of dead-burned magnesite were suspended. Its relative importance under normal conditions has not yet been demonstrated, as the demand for refractories and the quantity of magnesite imported have been subnormal until very recently.

Dead-burned dolomite sold or used, 1917–1922.

Year.	Reported as raw stone.		Reported as dead-burned.		Total quantity calculated as dead-burned (short tons).
	Short tons.	Value.	Short tons.	Value.	
1917	232,421	$171,257	232,300	$2,376,633	349,000
1918	490,863	560,209	318,896	4,097,819	564,000
1919	254,787	394,754	222,036	2,228,602	349,000
1920	612,800	742,020	316,293	3,732,522	623,000
1921	79,480	85,786	107,664	1,113,010	147,000
1922	146,640	172,251	348,838	2,813,946	422,200

BASIC MAGNESIUM CARBONATE.

Another magnesium product, which may be manufactured from magnesite but in this country is nearly or quite all made from dolomite, is the basic carbonate, also called light or technical carbonate and magnesia alba. It is mixed with asbestos fiber and used mainly for pipe and boiler coverings under the trade name "85 per cent magnesia." It may also be used in fire-retarding paint and in medicinal and toilet articles. The dolomite sold for the manufacture of basic magnesium carbonate is quarried in Pennsylvania and Wisconsin and is reported to the Survey only as raw stone.

Dolomite sold to magnesia works for manufacture of basic magnesium carbonate, 1916–1922.

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1916	80,867	$80,595	1920	57,300	$107,107
1917	73,214	89,189	1921	32,050	60,648
1918	90,989	126,255	1922	53,170	79,313
1919	62,652	82,619			

HIGH-MAGNESIUM LIME FOR SULPHITE PAPER MILLS.

Most of the processes for manufacturing paper require a high-calcium lime. The sulphite process, however, calls for either calcined magnesite, high-magnesium lime, or high-calcium limestone. High-calcium limestone is preferred to raw dolomite because most dolomite disintegrates to a sludge when attacked by dilute sulphurous acid. The magnesium bisulphite derived by the action of the acid is especially desired in the process, however, and calcined magnesite would doubtless be preferable but for its greater cost. It was formerly used for this purpose in the Pacific Coast States but has been nearly or quite all displaced by the cheaper high-magnesium lime. The high-magnesium lime used by sulphite pulp mills has been reported as burned lime and probably represents only part of the lime used for this purpose, as many lime producers who sell to paper mills do not specify the kind of mills to which their lime is shipped. The product comes from several States where magnesium lime is manufactured.

High-magnesium lime sold to sulphite paper mills, 1917–1922.

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1917	77,020	$422,026	1920	121,817	$1,347,321
1918	88,631	726,610	1921	68,992	711,345
1919	83,962	632,930	1922	70,000	650,000

CARBON DIOXIDE.

The dolomite sold for the manufacture of carbon dioxide comes from California and North Carolina. The greater part is from California and is practically all used by alkali works in the manufacture of sodium compounds.

Dolomite sold for the manufacture of carbon dioxide, 1917–1922.

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1917	31,000	$53,955	1920	33,040	$73,671
1918	16,770	22,500	1921	34,090	124,984
1919	16,870	39,895	1922	38,280	58,748

MAGNESIUM CHLORIDE.

The magnesium chloride considered here is obtained from bitterns or residual liquors left after the extraction of common salt and in some places of potash from brines. According to information received by the Geological Survey magnesium chloride was produced and sold or used in 1922 by four companies—two in California, one in Utah, and one in Michigan. Not all these companies reported sales to the Survey, but the total quantity sold or used is estimated to have been 13,000,000 pounds.

Before the war practically all the magnesium chloride used in the United States was imported from Germany, where it was made as a by-product in the manufacture of potassium chloride. Imports of this material were not recorded separately, however, until July, 1918. Figures compiled since that date by the Bureau of Foreign and Domestic Commerce are as follows:

Magnesium chloride imported for consumption in the United States, 1918–1922.

Year.	Pounds.	Value.	
		Total.	Average.
1918 (July–December)	13,076	$1,619	$0.124
1919	11,200	538	.048
1920	454,334	7,098	.016
1921	7,365,812	85,127	.012
1922	11,403,837	113,618	.010

The marked increase in imports and the rapid growth of domestic production reflect the rapid growth in demand, principally by manufacturers of magnesium oxychloride or Sorel cement, which is made from calcined magnesite and magnesium chloride with the addition of various fillers such as asbestos fiber, wood flour, talc, marble dust, or sand. Although this product had been extensively used in Europe, especially Germany, for a number of years, its use in this country has attained importance only since 1913 or 1914. Continued increase in its use may encourage other salt and potash companies to recover magnesium chloride from their brines.

Magnesium chloride is used also in the dressing of cotton goods, in the manufacture of metallic magnesium, mixed with ground magnesium oxide as a fire-resisting paint, to kill weeds, for application to dirt and water-bound macadam roads to counteract dusting and raveling, in the manufacture of magnesium oxide and hydrochloric acid, and as a drying agent.

During the war magnesium chloride was manufactured by passing solutions of hydrochloric acid over serpentine (hydrous silicate of magnesium), but the difficulty of obtaining a product sufficiently free from iron and the high cost of manufacture prevented the success of the enterprise. A good grade of magnesium chloride was made from imported Canadian magnesite during the war, but at high cost.

MIXED CALCIUM AND MAGNESIUM CHLORIDES.

The end liquor from which the greater part of the sodium chloride has been evaporated in the manufacture of common salt consists essentially of a mixture of calcium chloride and magnesium chloride. This impure mixture was formerly sold in large quantities for use on water-bound macadam roads, but at present the two chlorides in most of this end liquor, or bittern, are separated and sold as practically pure salts.

MAGNESIUM SULPHATE.

The natural magnesium sulphate sold in 1923 was derived mostly from a dry-lake deposit near Oroville, Wash., and from the bittern waters of certain salt works in California.

Before the war the only natural magnesium sulphate used in this country was a by-product of the German potash mines. Some of the purified magnesium sulphate (Epsom salts) has been manufactured in this country by treating magnesite or dolomite with acid. When imports were cut off the opportunity was given to develop by-product magnesium sulphate from bittern waters of salt works and to produce it from certain dry-lake deposits. It appeared doubtful whether this new industry could succeed after the war; but production has continued through 1922 and into 1923, and the product has found markets in the East and South as well as in the Western States and Canada.

The deposit near Oroville, Wash., was visited by J. T. Pardee, of the United States Geological Survey, in 1913 and in 1917 and the following is quoted from a press statement by him:

> Part of the crude material obtained from the lake is hauled and part of it is dissolved and pumped through a pipe line to a refinery on Similkameen River, which is said to produce about 20 tons of refined Epsom salts a day. Excavations made in the bed of the lake, which had been pumped virtually dry at the time of the examination, show many lenslike bodies of epsomite, the largest 15 feet thick, which was embedded in clay, both the clay and epsomite being covered by the persistent layer of clay that forms the present lake bed. The surface of this layer bears only thin crusts of epsomite, and the presence of the massive lenslike bodies beneath would hardly be suspected from a casual examination. These bodies are very coarsely crystalline and when freshly exposed are as clear as ice, but after exposure to the air for a short time the crystals lose water by evaporation and become white and opaque, showing an almost porcelainlike luster. The material is fairly pure, though most of the crystals inclose grains and masses of clay, and toward their margins the bodies become more or less split into layers that are interbedded with the clay. The deposit was evidently formed by repeated drying of the lake, the salt crusts being from time to time partly or completely buried by mud washed in from the surrounding land. Apparently the lenslike bodies were formed afterward by processes that collected and recrystallized the magnesium sulphate. Though the bed of this lake covers less than 5 acres, thousands of tons of epsomite have thus collected beneath it.

This and other saline deposits in the vicinity have been described by Jenkins[15] and Walker.[16]

Statistics of the imports of magnesium sulphate (Epsom salts), compiled from records of the Bureau of Foreign and Domestic Commerce, are shown below. Figures for earlier years may be found in previous chapters on magnesite.

Magnesium sulphate (Epsom salts) imported for consumption in the United States, 1918–1922.

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1918	2,045	$196	1921	12,519,778	$88,153
1919	17,647	1,473	1922	25,390,734	200,203
1920	1,803,769	66,944			

Exports of magnesium sulphate (Epsom salts) during 1922 amounted to 1,420,877 pounds, valued at $35,947.

STATISTICS OF MANUFACTURED MAGNESIUM SALTS.

Statistics in the preceding pages deal with materials as they left the producer. Supplementary figures compiled biennially by the Bureau of the Census, showing the quantity and value of manufactured magnesium salts, are given below. The raw materials from which these salts were made may include dolomite, magnesite, crude magnesium sulphate, and crude magnesium chloride, but the quantities of these materials so used have not been reported. They are partly or wholly included in the figures of production already given.

Manufactured magnesium salts produced in 1919 and 1921.

Salt.	1919			1921		
	Number of establishments.	Pounds.	Value.	Number of establishments.	Pounds.	Value.
Magnesium sulphate (Epsom salts)	20	58,696,632	$1,497,077	12	29,846,756	$753,822
Magnesium oxide	6	9,031,650	1,176,858	8	5,587,141	439,695
Magnesium chloride	7	26,282,437	495,087	3	.....	710,034
Magnesium carbonate (precipitated)	4	544,022	70,512	2	.....	
Other magnesium salts, etc	.....	.....	376,843	8	.....	289,574
	.....	.....	3,616,377	.....	.....	2,193,125

Imports of these compounds, as shown by figures compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the Geological Survey, were as follows:

[15] Jenkins, O. P., Spotted lakes of epsomite in Washington and British Columbia: Am. Jour. Sci., 4th ser., vol. 46, pp. 638–644, 1918.

[16] Walker, T. L., Epsomite lakes near Ashcroft, B. C.: Univ. Toronto Studies, Geol. ser. No. 12, pp. 43–45, 1922; Mineralog. Abstracts, vol. 1, p. 325, 1922.

Magnesium compounds imported for consumption in the United States, 1919–1922.

Year.	Calcined magnesia purified.		Carbonate precipitated.	
	Pounds.	Value.	Pounds.	Value.
1919	22,637	$11,358	5,094	$1,101
1920	26,859	9,093	14,930	1,512
1921	35,182	7,593	18,514	2,061
1922	96,792	15,969	36,254	3,385

Records of imports from September 22 to December 31, 1922, include also 2,406,330 pounds of magnesia "clay supporters, rings, rods, and other, for gas mantles." This quantity was valued at $7,366.

METALLIC MAGNESIUM.

PRODUCTION AND PRICES.

In 1922, as in 1921, only one company, the American Magnesium Corporation, of Niagara Falls, N. Y., reported production and sales of metallic magnesium to the Geological Survey; but one other producer was active also. An estimate of the quantity and value of the sales in 1922 is included in the following table:

Domestic metallic magnesium sold or used in the United States, 1918–1922.

Year.	Pounds.	Value.	Average price per pound.	
			Ingot (stick).	Powder.
1918	284,118	$615,217	$1.81	$2.67
1919	127,465	247,302	1.83	2.85
1920	(a)	(a)	1.60	2.75
1921	48,000	86,000	1.30	2.36
1922	[b] 60,000	[b] 89,000	1.60	1.13

[a] Survey not at liberty to show figures.
[b] Estimated.

The new magnesium produced was made mostly from California magnesite, and the remainder presumably from magnesium chloride. Although the output was three or four times as great as that produced in 1921, its production was still largely incidental to experimental work, and it was only toward the end of the year that the effect of the new tariff law became evident and the critical problems of production were finally solved.

The following articles on the manufacture of metallic magnesium and its properties have recently been published.

Boynton, K. S., Langford, Verne, and Hicks, J. F. G., Electrolytic recovery of magnesium from salt works residue: Jour. Ind. and Eng. Chemistry, vol. 14, No. 2, February, 1922, p. 146.

Allen, S. T., The production of metallic magnesium (from the chloride): The Electrician, Jan. 27, 1922, p. 92; reprinted in Chem. and Met. Eng., May 17, 1922, p. 987.

Edwards, J. D., and Taylor, C. S., Density of magnesium from 20° to 700° C. (paper presented at April meeting of Am. Inst. of Min. and Met. Eng., Cleveland, Ohio): Mining and Metallurgy, April, 1923, p. 209 (advance abstract).

The leading form of magnesium in both new production and in total sales was the ingot. The sales amounted to about 40,000 pounds, and stocks remaining at the end of 1922 were very small. Most of the ingot magnesium was sold at $1.60 a pound, as in 1920 and 1921,[17] but some may have been sold for less during the last third of the year. No attempt was made to meet the prices of the imported metal, which ranged from $1.10 to $1.30.

Almost no new magnesium powder was produced in 1922, and sales of it declined to about 7,000 pounds, owing to the continued dullness of the pyrotechnic business until late in the year and to the importation of a considerable quantity of German powder before the tariff act became effective. In addition to this quantity, about 40,000 pounds of the powder, originating in this country and exported to England, was returned to this country as surplus war stocks and still remains on the market. The average price of the domestic powder was $1.13, less than half the price in the four preceding years, and merely represents an attempt to dispose of a part of the surplus stocks in competition with the imported powder.

The quantities of magnesium castings, rods, and tubing sold or used increased, indicating the beginnings of the development of the use of magnesium for structural purposes. Small quantities of sheet, ribbon, and wire were also sold or used by the producer. A considerable quantity of magnesium alloys was produced, but less than half of it was sold or used.

IMPORTS.

Imports increased greatly in quantity in 1922 but decreased surprisingly in average value, as shown in the following table:

Magnesium imported for consumption in the United States, 1918–1922.[a]

Year.	Pounds.	Value.	
		Total.	Average.
1918, July to December[b]	11,899	$16,259	$1.37
1919	13,239	13,583	1.02
1920	29,275	25,055	.85
1921	39,913	30,592	.77
1922	182,939	54,448	.30

[a] Compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, by J. A. Dorsey, of the United States Geological Survey.

[b] Not separately classified prior to July, 1918.

[17] The average value of the high-grade metal in 1921 was $1.60 a pound, but sales of some inferior metal reduced the general average to $1.30.

The increase in imports that began late in 1921 grew rapidly, especially in the third quarter of 1922, as shown below:

Magnesium imported for consumption in the United States, 1921–22, by quarters.

	Pounds.	Value.
1921: First quarter	8,710	$8,234
Second quarter	14,566	11,360
Third quarter	2,765	3,564
Fourth quarter	13,872	7,434
1922: First quarter	19,641	7,959
Second quarter	33,908	13,843
Third quarter (July 1 to Sept. 21)	128,543	31,881
Fourth quarter (Sept. 22 to Dec. 31)	[a] 847	765

[a] Shipments to the United States during the last quarter were larger than is indicated by the records of imports for consumption, as it has been reliably reported to the Geological Survey that 12,102 pounds of magnesium, valued at $4,388, was received during October and November. Nearly all of this was pure metal priced at 36 cents a pound and was held in warehouse.

In anticipation of the passage of the tariff act several lots of surplus scrap metal were imported from Germany. These imports included considerable elektron, a magnesium alloy, much of which has remained unmarketed. The low value of the imports is evidently due largely to this alloy, which at the end of November, 1922, was quoted in Germany at wholesale prices of 1,240 marks per kilogram in pigs and 1,850 marks per kilogram in rods, equivalent to an average price of about 14 cents a pound, whereas the price of pure magnesium was 5,980 marks in bars and 5,925 marks in rods, equivalent to an average of about 35 cents a pound. Why the alloy should be so much cheaper than the pure metal is not clear, but it evidently can not have been made from pure magnesium.

Imports of magnesium powder have not been recorded separately, but one lot is said to have been offered for sale in this country at $1 a pound, and the 40,000-pound lot returned to this country was offered at 60 cents a pound.

TARIFF.

Duties placed by the new tariff act include the following:

Metallic magnesium and metallic magnesium scrap, 40 cents per pound; magnesium alloys, powder, sheets, ribbons, tubing, wire, and all other articles, wares, or manufactures of magnesium, not specially provided for, 40 cents per pound on the metallic magnesium content and 20 per cent ad valorem.

With these amounts added to the low prices stated under "Imports" it is still profitable to market German magnesium at $1 or $1.30 a pound; but the difference in price between imported and domestic magnesium will probably be small enough to curtail speculative buying of foreign magnesium.

OUTLOOK.

In spite of the low price of German magnesium, even under the tariff act, the domestic producer claims to be benefited by the fact that electrolytic magnesium made from the oxide (calcined magnesite) is free from even minute quantities of impurities, particularly chlorine, which in the presence of moisture promote corrosion.

As stated in the report for 1921, the problem of producing magnesium had then been practically solved, and the year 1922 was largely spent in perfecting technique and installing equipment for the production of semifinished structural forms, including castings, sheet, rod, tubing, wire, and forgings. Although further improvement is necessary for quantity production, alloys with a magnesium base can be furnished in these forms for special purposes. It is expected that during the year 1923 efforts will be made to build up a market where the distinctive qualities of magnesium make it particularly applicable for structural forms. These distinctive qualities are briefly described as follows:

Magnesium with a specific gravity of 1.74 to 1.80 is one-third lighter than aluminum, and for this reason its application and development in the parts of airplanes and the reciprocating parts of machinery and to replace wood where a metal is more desirable promise to consume a considerable quantity.

The strength of magnesium-base alloys in cast form is generally greater than that of equivalent aluminum alloys. Extruded and rolled or forged forms are from 80 to 90 per cent as strong as equivalent forms of the recently developed high-strength aluminum alloys. When these properties are better understood, the combined strength and lightness of magnesium may be expected to give it a definite place among engineering materials.

Another outstanding property of magnesium is the ease with which it can be machined. Machine-screw work is cheaper with magnesium than with brass or aluminum. Although magnesium is not so good a wearing or bearing material as some other metals, magnesium threads do not seize, and with proper lubrication the tendency to wear may be minimized.

Magnesium is affected by all acids except hydrofluoric, but it is not affected by alkalies or dry atmosphere. Moist air will tarnish a bright surface but will not produce spots of granular corrosion on the pure metal. Although more subject to oxidation and corrosion than aluminum, magnesium has the compensating property of taking paint, varnish, and other protective films and colors readily.

As improvement of technique and increased demand permit production in larger quantity, it is expected that the selling price of magnesium will be lowered to levels that, volume for volume, will permit a more reasonable competition with other structural materials on the basis of first cost. In the meantime efforts are being made to develop and extend its use where cost is subordinate to the superior properties of magnesium. It is believed that this market alone will permit a sufficient increase in production to assure the permanency of the magnesium industry.

STRONTIUM.[1]

By George W. Stose.

STRONTIUM ORE.

PRODUCTION.

No strontium ore has been mined in the United States since 1918. In that year a small quantity was mined in Barstow County, Calif., and in 1917 and 1916 deposits in Arizona, Texas, and Washington were worked on a small scale. Other workable deposits have been reported from these States and Utah, but not enough has been done on them to determine their quality and extent. All these deposits have been briefly described in the reports on strontium for 1916, 1918, and 1919. Most of the ore in these deposits is celestite (strontium sulphate), but that mined in California was chiefly strontianite (strontium carbonate). Interference with commerce during the World War created a market for domestic ores that resulted in temporary activity in the mining of strontium ore in this country, but this activity ceased as soon as foreign trade was reestablished.

IMPORTS.

The quantity of strontium ore imported can not be determined accurately, because a separate record of it was not kept in the customs offices at ports of entry prior to September 22, 1922, when the new tariff went into effect. Before 1916 about 2,000 short tons of ore was imported annually, but in later years the quantity imported has generally been considerably less, although the difference has been in part offset by the larger quantity of manufactured strontium chemicals imported. From September 22 to December 31, 1922, 1,000 pounds of strontianite and celestite was imported under the new tariff. This ore was probably finely ground or pulverized, as the value recorded was $80 a ton.

PRICES.

The price obtainable for domestic strontium ore in the United States is at present controlled by the value of the imported product delivered at the Atlantic ports of entry, because the factories that use most of the ore are in the eastern part of the country. The average price of the crude strontium ore imported in 1922 is not known, but it was apparently so low that domestic material from the Western States could not compete with the imported material. The

[1] Statistical data prepared chiefly by Mrs. E. R. Phillips. Statistics of imports compiled by J. A. Dorsey from the records of the Bureau of Foreign and Domestic Commerce.

establishment of a permanent domestic strontium-mining industry appears to be dependent on the development of western markets for strontium chemicals, such as would result from the use of strontium salts in the manufacture of beet sugar by a process in general use in certain parts of Europe.

STRONTIUM CHEMICALS.

PRODUCTION.

Most of the strontium chemicals manufactured in the United States in 1922 were made from celestite imported from England. The rest were made largely from chemically manufactured strontium carbonate imported from Germany. Strontium chemicals not made from ore are not included in the statistics of this report. Three plants made strontium chemicals from ore during the year, one each in Missouri, New Jersey, and Pennsylvania. The largest output was made by the plant of E. I. du Pont de Nemours & Co. at Paulsboro, N. J. Strontium nitrate was the chief strontium chemical made, but bromide, chloride, carbonate, sulphate, and small quantities of other medicinal chemicals were also produced. The total quantity of strontium chemicals produced and marketed by these three plants in 1922 was about 2½ times the quantity made in 1921 but less than half the quantity made in either 1918 or 1920.

Strontium chemicals manufactured from domestic and imported crude ore in the United States and sold in 1918–1922.

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1918	[a] 4,148,270	$622,546	1921	847,368	$118,655
1919	2,191,409	402,057	1922	2,040,550	204,022
1920	4,713,015	864,251			

[a] Revised figures.

IMPORTS.

Strontium nitrate was imported in larger quantity than any other strontium chemical in 1922. After September 22, when the new tariff went into effect, 360,781 pounds, valued at $20,831, was imported, and it is estimated that the imports during the entire year amounted to more than 1,000,000 pounds. This material was used chiefly in the manufacture of signals and fireworks. The amount of strontium carbonate and oxide imported declined in 1922 to less than one-fortieth the quantity imported in any of the three preceding years.

Strontium carbonate and strontium oxide [a] imported into the United States, 1919–1922.

[Value at point of shipment.]

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1919	1,225,952	$3,380	1921	1,212,758	$4,393
1920	1,659,083	15,479	1922	29,863	2,155

[a] "Oxide of strontium, protoxide of strontium, and strontianite or mineral carbonate of strontium" imported for consumption in the United States, compiled from the records of the Bureau of Foreign and Domestic Commerce.

USES AND MARKET.

Strontium compounds are used chiefly in the manufacture of signal lights and fireworks and in medicines. Celestite (strontium sulphate) is the most common strontium mineral. As strontium carbonate is a stable compound that is readily handled, stored, and shipped, a large part of the ore is converted into carbonate by treatment with soda ash (sodium carbonate) before it is exported to this country. Strontium carbonate is extensively used in the manufacture of other strontium compounds, and considerable quantities are imported for this purpose. Strontium nitrate can be made from it by treatment with nitric acid, but much of the strontium nitrate used in this country is made by converting ore (strontium sulphate) into sulphide by roasting with powdered coal and then treating the sulphide with nitric acid. Although strontium nitrate is not explosive, it breaks down readily and is not ideal for storing or shipping, but by using proper containers it is imported in large quantities. It is also the chief strontium compound made in domestic plants. The nitrate is used in the manufacture of pyrotechnic red fire and lights, railroad flares, signals, and fusees, signal shells, and signal lights. Strontium bromide, salicylate, chloride, and other compounds are made for medicinal use and chemical reagents. Strontium chemicals are now made chiefly in the Atlantic States and in Missouri, and during the World War some were made in California and Washington. The demand for domestic ore is at present confined largely to the Eastern States, where it must compete in price and quality with ore and strontium chemicals imported from foreign countries, chiefly from England and Germany.

The following companies dealt in or used strontium chemicals, manufactured from either crude ore or other strontium chemicals, in 1922:

Columbus Pharmacal Co., Columbus, Ohio.
H. P. Diehl, Lawrenceburg, Ind.
Dow Chemical Co., Midland, Mich.
E. I. du Pont de Nemours & Co., Wilmington, Del.
Heyden Chemical Works, New York, N. Y.
Hummel, Robinson Corporation, New York, N. Y.
A. Klipstein & Co., New York, N. Y.
Lehn & Finck (Inc.), New York, N. Y.
Mallinckrodt Chemical Works, St. Louis, Mo.
Merck & Co., New York, N. Y.
Meteor Products Co., New York, N. Y.
New Jersey Fireworks Co., Glassboro, N. J.
Pain's Fireworks Co., Dongan Hills, Staten Island, N. Y.
Porter Chemical Co., Hagerstown, Md.
Powers, Weightman, Rosengarten Co., Philadelphia, Pa.
Rochester Fireworks Co., Rochester, N. Y.
Roessler, Hasslacher & Co., New York, N. Y.
Unexcelled Manufacturing Co., New York, N. Y.

GRAPHITE.

By Arthur H. Redfield.[1]

PRODUCTION.

NATURAL GRAPHITE.

The sales of domestic graphite in the United States in 1922 showed an increase of 28 per cent in quantity, but the mining of graphite still showed the effects of the postwar depression, though there was a small gain in production after the new tariff law went into effect, September 22, 1922. This law imposed a duty of 10 per cent ad valorem on amorphous graphite, of 20 per cent ad valorem on crystalline lump, chip, or dust, and of 1½ cents a pound on crystalline flake. Imports increased from 8,183 short tons in 1921 to 12,488 short tons in 1922.

Domestic natural graphite sold in the United States, 1918–1922.

Year.	Amorphous.		Crystalline.	
	Short tons.	Value.	Pounds.	Value.
1918	6,560	$69,455	12,861,839	$1,454,799
1919	3,379	47,716	8,086,191	731,141
1920	4,694	49,758	9,632,360	576,444
1921	1,842	20,860	1,189,523	75,664
1922	2,200	(a)	1,849,766	85,242

a Value may not be published.

Number of operators reporting production of graphite, 1918–1922.

State.	1918	1919	1920	1921	1922
Alabama	25	10	7	2	3
California	1	1	1	1	1
Colorado	1	1	1	1	.....
Montana	1	.....	1	.....	.....
Nevada	1	1	1	1	1
New York	3	2	2	1	.....
Pennsylvania	6	3	1	.....	.....
Rhode Island	2	1	2	1	1
Texas	2	1	1	1	1
	42	20	17	8	7

The sales of crystalline graphite in 1922 showed an increase of 56 per cent in quantity and 13 per cent in value, as compared with 1921. This graphite was produced by only five firms operating in three

[1] Statistics relating to domestic production prepared by L. M. Beach; those relating to foreign production compiled by W. I. Whiteside.

States, and therefore State totals may not be published. Texas was the leading producer, Alabama ranked second, and California third.

The proportion of the available supply represented by the domestic output is shown in the following table:

Available supply of crystalline graphite in the United States, 1918–1922.

	1918	1919	1920	1921	1922
Short tons.					
Domestic production	6,431	4,043	4,816	595	925
Imports:					
Ceylon	9,029	9,451	9,204	2,311	7,258
Madagascar	970	10,016	4,710	1,078	1,305
Other countries	3,314	1,505	2,200	687	641
	13,313	20,972	16,114	4,076	9,204
Total available supply	19,744	25,015	20,930	4,671	10,129
Percentage represented by domestic production	32.6	16.2	23.0	12.7	9.13
Value.					
Domestic production	$1,454,799	$731,141	$576,444	$75,664	$85,242
Imports:					
Ceylon	2,397,735	1,530,281	1,077,290	199,440	332,195
Madagascar	265,338	1,205,350	286,383	67,509	52,275
Other countries	270,136	102,390	159,517	48,035	24,673
	2,933,209	2,838,021	1,523,190	314,984	409,143
Total available supply	4,388,008	3,569,162	2,099,634	390,648	494,385
Percentage represented by domestic production	33.2	20.5	27.5	19.4	17.24

Eight of the 13 firms that reported sales of crystalline graphite in 1920 stated that their mines were idle in 1922. The active firms were as follows:

Ceylon Co., Birmingham, Ala.
Flaketown Graphite Co., Mountain Creek, Ala.
California Graphite Co., Los Angeles, Calif.
Pocahontas Graphite Co., Ashland, Ala.
Southwestern Graphite Co., Boston, Mass. (operating in Texas).

In 1922 the quantity of amorphous graphite sold increased 19 per cent. The supply was furnished by the Graphite Mines Corporation, New York, N. Y., operating in Rhode Island, and the Carson Black Lead Co., Oakland, Calif., operating at Carson, Nev.

MANUFACTURED GRAPHITE.

Graphite is manufactured by the Acheson Graphite Co. at Niagara Falls, N. Y. The figures given below, published by permission of this company, represent only the manufactured graphite that comes into competition with natural graphite.

Graphite manufactured by the Acheson Graphite Co., 1917–1922, in pounds.

1917	10,474,649	1920	7,399,749
1918	9,182,272	1921	5,888,000
1919	8,163,177	1922	13,031,926

IMPORTS AND EXPORTS.[1]

The reports of the Bureau of Foreign and Domestic Commerce as to imports show only the country shipping the goods, which is not invariably the country of origin. For example, the graphite entered in that bureau's statements as imported from France probably originated in Madagascar, and that imported from Great Britain should probably be credited to Ceylon and possibly in part to Madagascar. The shipments from Japan probably consisted of graphite from Chosen. In this chapter the graphite imported from the United Kingdom has been arbitrarily credited to Ceylon, that imported from France to Madagascar, and that imported from Japan to Chosen. Imports of more doubtful origin are included under "Other countries."

Graphite imported into the United States, 1916–1922.

[General imports.]

Country of origin.	1916	1917	1918	1919	1920	1921	1922
Short tons.							
Ceylon	26,232	24,575	9,029	9,451	9,204	2,311	7,258
Madagascar	1,631	4,393	970	10,016	4,710	1,078	1,305
Canada	4,127	3,476	3,084	1,504	2,170	687	533
Brazil	1	18	45				
Mexico	5,331	7,570	5,600	5,506	3,659	3,404	2,197
Chosen (Korea)	5,375	2,462	568	126	810	646	1,170
Italy	151	115	17	22	137	47	35
Austria					58		
Germany					30		6
Other countries	169		185	1	317	10	102
	43,017	42,609	19,498	26,626	21,095	8,183	12,606
Value.							
Ceylon	$6,356,532	$7,179,208	$2,397,735	$1,530,281	$1,077,290	$199,440	$332,195
Madagascar	241,863	1,057,081	265,338	1,205,350	286,383	67,509	52,275
Canada	314,177	349,034	236,226	102,163	157,015	48,035	17,392
Brazil	75	4,380	7,351				
Mexico	238,000	285,568	134,183	135,464	131,832	120,153	40,954
Chosen (Korea)	103,619	83,558	24,455	3,948	29,936	15,145	29,819
Italy	4,133	3,092	628	663	5,072	1,019	1,045
Austria					1,195		
Germany					2,502		425
Other countries	21,484	67	26,559	227	20,087	775	6,856
	7,279,883	8,961,988	3,092,475	2,978,096	1,711,312	452,076	480,961

Graphite imported for consumption in the United States, 1913–1922.

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1913	28,879	$2,109,791	1918	19,498	$3,092,475
1914	21,990	1,398,209	1919	26,626	2,978,096
1915	23,075	2,241,163	1920	21,095	1,711,312
1916	42,930	7,279,883	1921	8,183	452,076
1917	42,577	8,961,988	1922	12,488	473,046

In 1922 the imports of crystalline graphite increased 126 per cent in comparison with 1921; this gain far outstripped the increase of 56 per cent in domestic production.

[1] The figures showing imports and exports were compiled by J. A. Dorsey, of the United States Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

The quantity of graphite annually exported from the United States is very small. In 1922 there was a decrease of 38 per cent in the quantity of unmanufactured graphite exported, but the value decreased only 19 per cent, increasing from 5.21 to 6.86 cents a pound.

Graphite exported from the United States, 1917–1922.

Year.	Unmanufactured graphite.		Manufactures of graphite.	Year.	Unmanufactured graphite.		Manufactures of graphite.
	Pounds.	Value.			Pounds.	Value.	
1917	5,146,816	$349,563	$891,687	1920	1,213,616	$112,771	$610,261
1918	1,907,719	121,555	731,518	1921	1,841,578	95,998	679,359
1919	1,258,040	90,185	788,755	1922	1,138,708	78,094	[a] 255,019

[a] Exclusive of crucibles, figures for which are not available.

The exports of lead pencils and pencil leads and of crucibles are not included in the tables showing articles of manufactured graphite but are given separately. The value of the pencils and leads exported in 1922 was $1,659,201, or 20 per cent less than the corresponding value in 1921, which was $2,074,508. Crucibles to the number of 355,155, valued at $92,273, were exported in 1922. In this number were included, however, both graphite crucibles and an unknown number of clay crucibles of low price.

PRICES.

In 1922 the price of domestic flake graphite ranged from 4 to 5 cents a pound; in 1921 from 2 to 13 cents. The average price of domestic flake at the mines in 1922 was 4.6 cents, which was 1.8 cents less than in 1921.

The accompanying table is based on information furnished by importers prior to 1920. The figures for 1920, 1921, and 1922 were furnished by Mr. Charles Pettinos, of New York. The low prices shown reflected the general depression of the graphite market in the United States.

Average prices of Ceylon graphite c. i. f. New York, 1914–1922.

[Cents per pound.]

Year.	Lump.		Chip.		Dust.		Remarks.
	First grade.	Second grade.	First grade.	Second grade.	First grade.	Second grade.	
1914	6½– 9½	7½– 8½	7½– 7¾	6½– 7	4¾– 5½	3½– 4	Low, first half; high, second half.
1915	9⅝–20	8 –14	7 –14	6½–12	7½– 9½	6½– 9½	Do.
1916	20 –28	14 –21	13½–20	11½–17	9½–12	9½–10	Do.
1917	28 –32	21 –23	20 –23	17 –19	11–13	10–12	High level maintained throughout the year.
1918	28½–15¼	22 –14	21½–12½	18½–11	12–10½	10 – 9	High, first half; low, second half.
1919	14 –15¼	12 –13	10 –11	8 – 9	6¾– 7½	5 – 6	Low throughout the year.
1920	14 – 9	11 – 7	10 – 7	7½– 5½	7 – 5	5 – 3½	High, first half; low, second half.
1921	5½– 6	4½– 5	4½– 5	3½– 4	3¼– 3¾	2 – 2½	Low throughout the year.
1922	5 – 6	4 – 4½	4¼– 3¾	3¼– 3¼	3 – 3½	2 – 2½	Do.

REVIEW OF WORLD'S GRAPHITE INDUSTRY.

Recovery from the depression of 1920 and 1921 marked the year 1922 in the mining of graphite. With but few exceptions all the producing countries increased their output of graphite, both crystalline and amorphous. The general revival of industry after the postwar depression of 1919 and 1920 in Europe has resulted in an increased demand for graphite crucibles, foundry facings, lubricants, lead pencils, and other manufactures of graphite. The world's production has consequently risen from an estimated total of 87,167 metric tons in 1921 to an estimated total of 110,000 tons in 1922.

The world market is still depressed, however, by the existence of large stocks of unsold graphite held by producers in Madagascar, in Ceylon, and in Alabama, as well as in the hands of German, French, British, and American dealers. These stocks represent for the most part an overproduction of graphite in 1917 and 1918 and an accumulation of unsold output of 1919, 1920, and 1921, when the demand for graphite fell below normal. These stocks, of which no exact totals are available, must be absorbed before the graphite industry of the world will be on a stable basis.

World's production of natural graphite, 1919–1922, in metric tons.

	1919	1920	1921	1922
United States: [a]				
Amorphous	3,065	4,258	1,671	1,996
Crystalline	3,668	4,369	540	839
Canada [a]	1,234	1,987	850	[b] 590
Greenland	[d]	[c] 1,380	2,000	[d]
Mexico	4,023	2,992	2,911	[e] 2,054
Brazil [f]	2			
Austria	8,265	11,543	13,280	[c] 11,650
Czechoslovakia	31,234	22,925	[c] 20,000	[c] 22,000
Finland	30	27	[d]	[d]
France	650	272	[d]	[d]
Germany	30,525	20,639	[e] 24,565	[c] 30,000
Italy	7,626	5,398	5,233	[b] 7,300
Norway		10		
Spain	1,958	6,315	2,772	[d]
Sweden		7		[d]
British India	129	102	25	[d]
Ceylon [f]	6,779	9,353	4,419	11,023
French Indo-China [f]	7,451			
Japan	1,954	1,133	[e] 842	[c] 1,000
Chosen [f]	12,945	18,259	8,015	19,362
Madagascar	4,983	4,000	[g]	[g]
Union of South Africa	78	66	44	[c] 38
Australia	102	54		[d]
	126,701	115,089	[c] 87,167	[c] 110,000

[a] Shipments. [b] Preliminary. [c] Estimated. [d] No data. [e] Unofficial. [f] Exports. [g] Negligible.

Graphite mining in Canada and in Mexico shared in the depression felt by the industry in the United States. No graphite was mined in Canada during 1922. The Black Donald mill, at Whitefish Lake, Ontario, was operated intermittently during the year and treated 1,700 tons of ore mined in 1921, and the Quebec Graphite Co. made some shipments from stock. Shipments from Mexico to the United States through Nogales, Ariz., during 1922, according to the Bureau of Foreign and Domestic Commerce, amounted to only 1,993 metric tons (1,962 long tons), as compared with 3,088 metric tons (3,039 long tons) in 1921 and 3,319 metric tons (3,267 long tons) in 1920.

In view of the lack of statistics of graphite production, conditions in Germany must be inferred rather than described. The German production of graphite in 1922 is estimated at 30,000 metric tons. In 1922, as in 1921, the depreciation of the mark in German exchange protected the Bavarian graphite producer from any very strong competition from Ceylon or Madagascar graphite. For central Europe Germany is the principal market for graphite. German statistics of imports and exports of graphite and graphite products in 1922 indicate an increased consumption of graphite in Germany. This demand aided the production of raw graphite in Austria and Czechoslovakia, where the graphite industry depends rather on the German than on the domestic market. A rise in railroad rates in Austria placed the Austrian and Styrian producers at a disadvantage on the German market as compared with the Bohemian and Moravian producers, who are nearer at hand. This difference resulted in a decreased production in 1922 in Austria as contrasted with the increased production in Czechoslovakia.

The Ceylon graphite industry was revived by the increasing demand. A total of 216,999 hundredweight (11,023 metric tons) was exported from the island in 1922. About 64.6 per cent of the 1922 exports went to the United States, 10.15 per cent to the United Kingdom, 9 per cent to Germany, and 8.7 per cent to Japan. Stocks of graphite held in Ceylon on January 1, 1923, were estimated at 15,100 tons.

Exports from Chosen in 1922 increased markedly over those of 1921 and even surpassed those of 1920. They included 28,571 piculs (1,717 metric tons) of flake graphite and 293,596 piculs (17,645 metric tons) of amorphous graphite. About 95 per cent of these shipments went to Japan, to be for the most part manufactured or reexported. A revival in the Japanese lead-pencil industry, which consumes a large part of the Chosen graphite, is indicated by the increased exports of lead pencils from Japan during the first eleven months of 1922.

The situation in Madagascar shows no signs of improvement. Stocks held in the colony on January 1, 1922, were officially estimated at 18,000 to 20,000 metric tons, or at the same amount as at the beginning of 1921. Exports during 1922 amounted to 6,675 tons, as compared with 6,220 tons in 1921 and 4,425 tons in 1920. The exports in 1922 were almost entirely taken from old stocks. Shipments to Great Britain consisted chiefly of the purchases of a single crucible manufacturer; shipments to France and Germany were made on consignment. Little graphite was mined in the colony during 1922.

FULLER'S EARTH.

By Jefferson Middleton.[1]

GENERAL CONDITIONS.

The rapid increase in output and value of fuller's earth that began in 1913 and was interrupted in 1921 was resumed in 1922, the output in that year reaching the highest point recorded. This output was 32 per cent more than that of 1921 and 8 per cent more than that of 1920, the year of greatest output next to 1922. The value of fuller's earth marketed in 1922 was exceeded only by that of 1920. It was 9 per cent less than that of 1920 but 16 per cent more than that of 1921. The imports of fuller's earth also increased in quantity and value. The rate of duty under the tariff act of 1922 is $1.50 per long ton for unwrought or unmanufactured fuller's earth and $3.25 per long ton on wrought or manufactured. These rates are increases of 75 cents and $1.75 per ton, respectively, over those in the tariff act of 1913.

An interesting development in the industry is the entrance into the ranks of producers of Illinois and Pennsylvania. Illinois gives promise of becoming an important producer, and a brief description of the developments in that State is given in the following extract:[2]

> The deposit at Caledonia Landing, as the river front at Olmstead is called, belongs to the Midway formation of the Tertiary system. As already stated, it appears as a bluff about 112 feet high extending along the shore of the river for about 2 miles. * * * The earth is being dug in an open pit, which covers an area of about 2 acres. The overburden of 10 feet of sand and loam is loosened by shooting and then removed in wheelbarrows. Below this there is a working face of 34 feet, which is the best quality fuller's earth. The earth presents a distinctly jointed structure and is readily dislodged by prying with bars and shooting. Below this face there is 30 feet of an inferior grade of earth which has only about 80 per cent of the efficiency of the upper portion. The earth thus loosened is loaded into small cars, which are hoisted by cable on an inclined track and dumped into a receiving bin at the factory. As the raw material comes out of the pit it is in the form of large lumps of a dark-brown color having a fair degree of hardness. These are reduced to cubes of 1-inch size by crushing with differential rolls having breaker bars on one roll. These small lumps are fed into a rotary oil-burning direct-flame drier 20 feet long and 3 feet in diameter. The maximum temperature reached in this drier is 900° F. The earth passes through this drier in 12 minutes, and during its travel the water content is decreased to 3 to 5 per cent. This is accompanied by a brisk

[1] The statistical data of this report have been prepared by Miss Katrine W. Cottrell, and the table of imports was compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, of the United States Geological Survey.

[2] Parmelee, C. W., Fuller's earth deposit at Olmstead, Ill.; Chem. and Met. Engineering, vol. 26, No. 4, Jan. 25, 1922, p. 177.

reduction in the size of the lumps due to the popping caused by the rapid removal of the water content. Further crushing is done in a "hummer" mill, where the grain is reduced to pass 10 mesh. The pulverized material is elevated and passed over inclined screens which are electrically vibrated. Three grades are separated—the 16–30 mesh, for the bleaching and filtration of mineral oil; the 30–60 mesh, for the same purpose; the 60–300 mesh, for filtering lard, vegetable oils, soap stock, etc. The screened dry material is sacked and is then ready for shipment. It is very hygroscopic and takes up about 12 per cent of water during storage and shipping. * * * The total amount of fuller's earth available is estimated as 4,000,000 tons. The central location of this deposit with reference to the mineral and vegetable oil refineries, its easy accessibility by water and rail, and the great quantity of the raw material will make Illinois one of the important producers.

The consumption, which is practically production plus imports, in 1922 was 149,513 short tons, or about 30 per cent greater than that of 1921 and 1 per cent greater than that of 1920. Domestic earth constituted 93 per cent of the consumption in 1922.

OCCURRENCE.

Fuller's earth has been reported in Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Illinois, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, Nevada, New York, Pennsylvania, South Carolina, South Dakota, Texas, Utah, Virginia, and Washington, but in 1922 it was produced only in Alabama, Arkansas, Florida, Georgia, Illinois, Massachusetts, Pennsylvania, and Texas.

PRODUCTION.

Fuller's earth produced and marketed in the United States, 1916–1922.

Year.	Operators reporting sales.	Short tons.	Value at mines.	
			Total.	Average.
1916	10	67,822	$706,951	$10.42
1917	11	72,567	772,087	10.64
1918	14	84,468	1,146,354	13.57
1919	10	106,145	1,998,829	18.83
1920	12	128,487	2,506,189	19.51
1921	12	105,609	1,973,848	18.69
1922	15	138,944	2,289,719	16.48

The small number of producers in some States makes it impossible to publish totals for these States without disclosing individual operations. All the earth produced came from the Southern States except that of one operator each in Illinois, Massachusetts, and Pennsylvania. Florida was the leading producing State, as it has been since the beginning of the industry, and reported 64,122 tons, valued at $1,122,940, or $17.51 a ton. This was 46 per cent of the total output and 49 per cent of the total value. Georgia was second and Texas third. These three States reported 97 per cent of the output and value.

IMPORTS.

The imports of fuller's earth, which at one time constituted the entire supply, were increasing before the war and reached their maximum in 1914. During the war imports naturally decreased. Im-

mediately after the war they increased but did not reach the pre-war record, and in 1921 they made a sudden drop, reaching the lowest quantity since 1900. In 1922 the imports increased slightly in quantity (8 per cent) but were, except for those of 1921, the smallest since 1904. Owing, however, to the higher prices obtained in later years the value of the imports in 1922 at the principal markets of the countries of export was not so low comparatively and was greater than that of any year prior to 1911. Wrought or manufactured earth represents about 95 per cent of the quantity and value of imports.

Fuller's earth imported and entered for consumption in the United States, 1917–1922.

Year.	Unwrought or unmanufactured.			Wrought or manufactured.			Total.		
	Short tons.	Value.		Short tons.	Value.		Short tons.	Value.	
		Total.	Average.		Total.	Average.		Total.	Average.
1917	1,441	$11,718	$8.13	15,553	$164,699	$10.58	16,994	$176,417	$10.38
1918	1,085	12,636	11.65	15,837	213,599	13.49	16,922	226,235	13.37
1919	373	4,301	11.53	13,500	185,410	13.73	13,873	189,711	13.67
1920	1,518	19,793	13.04	17,497	202,100	11.55	19,015	221,893	11.67
1921	483	6,172	12.78	9,261	113,243	12.23	9,744	119,415	12.26
1922	607	7,413	12.21	9,962	128,282	12.88	10,569	135,695	12.84

CLAY.

By Jefferson Middleton.

GENERAL CONDITIONS.

Clay available for the manufacture of clay products is widely distributed in the United States, and there are clay-working plants in every State in the Union. The following tables represent chiefly clay that is mined and sold as clay. The quantity thus sold is small compared with the total output and includes mainly clay used for making high-grade pottery and tile and refractory products. The values given for domestic production are values f. o. b. at the mines. The values of imports are those at the principal markets of the countries from which the clay is exported. The values of exports are those at the ports of shipment.

The general increase in prosperity in 1922 had a marked effect on the clay-mining industry, the clay sold increasing 52 per cent in quantity and 38 per cent in value compared with 1921. Fire clay, which constitutes the largest volume of the clay sold, being 63 per cent of the total in 1922, showed the largest increase in quantity and value. Every kind of clay as classified in this report, except slip clay, increased in quantity and every kind except stoneware clay increased in value, as compared with 1921. Imports increased in quantity and value about 68 per cent, and exports also increased but not in so large proportion as production and imports. The duties on clay imposed by the act of 1922 are as follows: Kaolin, china, and paper clay, $2.50 per ton; other clays, not specially provided for, crude, $1 per ton, washed or manufactured, $2 per ton; common blue and Gross Almerode glass-pot clay, unwrought, $1 per ton, wrought or manufactured, $2 per ton.

For the first time an effort has been made by the Geological Survey to obtain figures showing the production of the so-called diaspore clay of east-central Missouri as distinct from the flint and other clays of that region. According to the returns 13,384 tons of diaspore clay, valued at $109,229, was shipped during 1922. This material is used principally in making high-grade refractories and abrasives. A recent article[1] describes the occurrence, composition, and possible supply of this material. Another paper[2] describes the composition and properties of diaspore, bauxite, and gibbsite, which are related minerals.

[1] Wysor, D. C., Diaspore clay of Arkansas and Missouri: Am. Ceramic Soc. Jour., vol. 6, No. 3, pp. 501–509, March, 1923.
[2] Howe, R. M., and Ferguson, R. F., idem, pp. 498–500.

An interesting development in the clay industry is the utilization of some of the claylike material of the leverrierite-bentonite group, after chemical treatment, as a clarifying agent for mineral oils, with results that are said to be far superior to those obtained with natural fuller's earth. This material is also being used successfully in the manufacture of soap. It occurs in large quantities in the far western States and to some extent in other States.

The most striking feature of the industry in 1922 was the large increase in the production of kaolin, china clay, and paper clay, which was 69 per cent more than the production in 1921 and was the largest on record—more than twice that of any year prior to 1912. The number of States reporting this high-grade clay also increased to 14 in 1922, as compared with 11 in 1921.

PRODUCTION.

Domestic clay sold in the United States, 1913–1922, by kinds.

Year.	Kaolin, china clay, and paper clay.		Ball clay.		Slip clay.		Fire clay.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1913	155,211	$803,434	67,134	$237,672	10,902	$24,505	1,820,379	$2,592,591
1914	150,519	843,151	67,927	255,767	8,237	17,731	1,409,467	2,147,277
1915	141,064	781,142	75,348	301,910	7,646	18,774	1,570,481	2,361,482
1916	201,157	1,075,730	89,761	391,152	14,064	47,939	2,057,814	3,708,009
1917	206,334	1,263,799	107,406	569,240	16,972	70,505	2,347,972	5,625,095
1918	179,694	1,459,529	89,896	590,631	13,552	49,898	2,305,033	5,664,064
1919	152,828	1,475,681	65,026	520,849	5,149	17,556	1,755,331	4,628,605
1920	268,203	2,865,407	69,477	584,611	9,006	41,519	[a] 2,261,915	[a] 7,088,049
1921	162,726	1,579,163	54,014	354,565	4,608	14,841	1,195,861	3,560,373
1922	275,675	2,346,095	76,792	440,877	4,050	19,405	1,679,220	4,633,486

Year.	Stoneware clay.		Brick clay.		Miscellaneous clay.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1913	153,353	$143,587	158,890	$137,976	282,120	$240,694	2,647,989	$4,180,459
1914	130,383	116,610	199,154	161,852	244,173	214,180	2,209,860	3,756,568
1915	134,297	126,429	101,968	93,863	332,150	288,341	2,362,954	3,971,941
1916	135,958	137,779	97,164	76,854	336,672	314,311	2,932,590	5,751,774
1917	81,352	113,839	93,779	94,703	260,029	305,365	3,113,844	8,042,546
1918	86,800	147,098	(b)	(b)	301,386	421,421	2,976,361	8,332,641
1919	60,236	80,367	(b)	(b)	236,530	367,573	2,275,100	7,090,631
1920	106,350	229,221	(b)	(b)	322,100	467,856	[a] 3,037,051	[a] 11,276,663
1921	86,574	184,540	(b)	(b)	[a] 242,963	[a] 361,818	[a] 1,746,746	[a] 6,055,300
1922	86,866	164,870	(b)	(b)	525,097	725,781	2,647,700	8,330,514

[a] Revised figures. [b] Included under "Miscellaneous clay."

Clay sold in the United States in 1921, by States and kinds.

State.	Number of active operators reporting.	Kaolin, china clay, and paper clay.		Ball clay.		Fire clay.	
		Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama	6	.....	.....	1,332	$10,659	45,520	$38,077
Arkansas	(a)	.....	.....	.....	.....	193	2,189
California	15	2,507	$35,586	7,828	16,753	101,183	174,996
Colorado	13	.....	.....	.....	.....	90,576	113,100
Connecticut	(a)	.....	.....	.....	.....	.....	.....
Delaware	3	(a)	(a)	.....	.....	(a)	(a)
Florida	3	28,426	388,751	.....	.....	.....	.....
Georgia	14	52,500	388,480	.....	.....	2,660	11,735
Idaho	(a)	.....	.....	.....	.....	196	2,369
Illinois	16	.....	.....	.....	.....	62,137	131,943
Indiana	15	.....	.....	.....	.....	35,171	56,156
Iowa	4	.....	.....	.....	.....	.....	.....
Kentucky	17	.....	.....	16,245	107,310	19,145	96,068
Maryland	11	(a)	(a)	.....	.....	12,858	29,171
Massachusetts	(a)	.....	.....	.....	.....	.....	.....
Michigan	4	.....	.....	.....	.....	.....	.....
Minnesota	(a)	.....	.....	.....	.....	.....	.....
Mississippi	(a)	.....	.....	.....	.....	.....	.....
Missouri	29	689	7,761	.....	.....	255,794	929,774
Montana	(a)	.....	.....	.....	.....	523	2,811
Nebraska	(a)	.....	.....	.....	.....	55	350
New Jersey	40	.....	.....	8,230	62,638	195,572	842,257
New Mexico	(a)	.....	.....	.....	.....	(a)	(a)
New York	5	.....	.....	.....	.....	244	2,928
North Carolina	3	11,681	188,825	.....	.....	.....	.....
North Dakota	(a)	.....	.....	.....	.....	16	183
Ohio	57	.....	.....	.....	.....	89,632	205,777
Oregon	(a)	.....	.....	.....	.....	.....	.....
Pennsylvania	73	12,331	146,768	.....	.....	220,578	713,345
South Carolina	7	35,866	273,867	.....	.....	.....	.....
South Dakota	(a)	.....	.....	.....	.....	.....	.....
Tennessee	12	.....	.....	20,379	157,205	32,513	130,167
Texas	9	.....	.....	.....	.....	2,075	10,625
Utah	4	.....	.....	.....	.....	(a)	(a)
Vermont	(a)	2,560	35,210	.....	.....	.....	.....
Virginia	3	(a)	(a)	.....	.....	670	2,465
Washington	3	.....	.....	.....	.....	(a)	(a)
West Virginia	5	.....	.....	.....	.....	25,244	42,595
Wisconsin	(a)	.....	.....	.....	.....	.....	.....
Wyoming	3	.....	.....	.....	.....	.....	.....
Undistributed	15	16,166	113,915	.....	.....	3,306	21,292
	389	162,726	1,579,163	54,014	354,565	1,195,861	3,560,373
Average price per ton	.....	.....	9.70	.....	6.56	.....	2.98

a Included under "Undistributed."

Clay sold in the United States in 1921, by States and kinds—Continued.

State.	Stoneware clay.		Miscellaneous clay.[b]		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama					46,852	$48,736
Arkansas					193	2,189
California	4,572	$9,460	64,949	$104,493	181,039	341,288
Colorado			4,189	5,991	94,765	119,091
Connecticut	139	480			139	480
Delaware					2,137	17,314
Florida					28,426	388,751
Georgia			[c] 30,000	[c] 30,000	[c] 85,160	[c] 430,215
Idaho					196	2,369
Illinois	25,255	41,921	(a)	(a)	89,060	177,004
Indiana	527	527	7,394	12,254	43,092	68,937
Iowa			7,457	7,617	7,457	7,617
Kentucky			197	1,022	35,587	204,400
Maryland	(a)	(a)	6,100	12,700	26,108	54,471
Massachusetts			26	90	26	90
Michigan			692	2,355	692	2,355
Minnesota			29,222	43,065	29,222	43,065
Mississippi			1,000	2,000	1,000	2,000
Missouri			300	600	256,783	938,135
Montana					523	2,811
Nebraska					55	350
New Jersey	16,354	71,919	43,022	72,934	263,178	1,049,748
New Mexico					(a)	(a)
New York			4,003	13,495	4,247	16,423
North Carolina	(a)	(a)	(a)	(a)	11,712	188,862
North Dakota					16	183
Ohio	37,279	51,915	23,991	19,822	150,902	277,514
Oregon	223	836	1	21	224	857
Pennsylvania	1,712	6,334	19,558	28,947	254,179	895,394
South Carolina	25	25			35,891	273,892
South Dakota			900	9,000	900	9,000
Tennessee	37	37			52,929	287,409
Texas	295	474			2,370	11,099
Utah			(a)	(a)	(a)	(a)
Vermont					2,560	35,210
Virginia			(a)	(a)	9,430	92,730
Washington			(a)	(a)	439	5,153
West Virginia					25,244	42,595
Wisconsin			160	480	160	480
Wyoming			433	2,155	433	2,155
Undistributed	156	612	3,977	7,618	3,420	14,928
	86,574	184,540	[c d] 247,571	[c d] 376,659	[c] 1,746,746	[c] 6,055,300
Average price per ton		2.13				3.47

[a] Included under "Undistributed."

[b] Includes adobe, ardmorite, bentonite, black-burning clay, shale and clay for building brick, cement, conduits, flowerpots, foundries, graphite crucibles, hollow tile, modeling, mortar, oilcloth, paint, pencil leads, plaster, sewer pipe, and terra cotta. Slip clay is also included in this column as a matter of convenience.

[c] Revised figures.

[d] These totals include 4,608 tons of slip clay, valued at $14,841, or $3.22 per ton, from California, Kentucky, Michigan, and New York.

Clay sold in the United States in 1922, by States and kinds.

State.	Number of active operators reporting.	Kaolin, china clay, and paper clay.		Ball clay.		Fire clay.	
		Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama	8	220	$660	.....	.....	55,483	$44,355
Arkansas	(a)	.....	.....	.....	.....	176	1,848
California	20	2,683	38,280	6,726	$22,944	134,194	232,689
Colorado	19	.....	.....	.....	.....	44,293	65,007
Connecticut	(a)	.....	.....	.....	.....	.....	.....
Delaware	3	1,076	14,000	.....	.....	(a)	(a)
Florida	(a)	(a)	(a)	.....	.....	.....	.....
Georgia	14	100,668	709,745	.....	.....	2,235	8,550
Idaho	(a)	.....	.....	.....	.....	394	2,410
Illinois	17	.....	.....	3,184	8,945	96,417	183,786
Indiana	13	.....	.....	.....	.....	40,324	61,967
Iowa	5	.....	.....	.....	.....	.....	.....
Kentucky	17	.....	.....	26,148	128,028	41,437	142,680
Maryland	16	5,300	7,400	.....	.....	11,099	55,144
Massachusetts	4	.....	.....	.....	.....	953	3,704
Michigan	4	.....	.....	.....	.....	.....	.....
Minnesota	(a)	.....	.....	.....	.....	.....	.....
Mississippi	(a)	.....	.....	.....	.....	1,080	2,160
Missouri	34	1,013	9,810	.....	.....	b 409,865	b 1,226,953
Montana	(a)	.....	.....	.....	.....	3,430	5,416
Nebraska	(a)	.....	.....	.....	.....	248	890
Nevada	(a)	(a)	(a)	.....	.....	.....	.....
New Jersey	42	.....	.....	9,314	66,555	244,240	979,345
New Mexico	5	.....	.....	.....	.....	1,681	6,542
New York	6	.....	.....	.....	.....	124	1,240
North Carolina	5	14,586	214,552	.....	.....	.....	.....
North Dakota	(a)	33	306	.....	.....	12	168
Ohio	57	.....	.....	.....	.....	183,701	362,049
Oregon	(a)	.....	.....	.....	.....	.....	.....
Pennsylvania	75	44,289	297,197	.....	.....	290,701	936,134
South Carolina	9	53,345	414,855	.....	.....	(a)	(a)
South Dakota	(a)	.....	.....	.....	.....	.....	.....
Tennessee	11	.....	.....	31,420	214,405	42,245	146,802
Texas	9	.....	.....	.....	.....	3,504	22,526
Utah	6	.....	.....	.....	.....	3,039	17,184
Vermont	(a)	(a)	(a)	.....	.....	.....	.....
Virginia	3	(a)	(a)	.....	.....	663	2,459
Washington	7	.....	.....	.....	.....	5,681	12,779
West Virginia	5	.....	.....	.....	.....	58,692	94,371
Wisconsin	(a)	.....	.....	.....	.....	.....	.....
Wyoming	3	.....	.....	.....	.....	.....	.....
Undistributed	21	52,462	639,290	.....	.....	3,309	14,328
	438	275,675	2,346,095	76,792	440,877	b 1,679,220	b 4,633,486
Average price per ton	.....	.....	8.51	.....	5.74	.....	2.76

a Included under "Undistributed."
b These totals include 13,384 tons of diaspore clay from Missouri, valued at $109,229.

Clay sold in the United States in 1922, by States and kinds—Continued.

State.	Stoneware clay.		Miscellaneous clay.[c]		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama			4,820	$4,750	60,523	$49,765
Arkansas					176	1,848
California	9,864	$16,864	53,273	85,424	206,740	396,201
Colorado	1,408	3,520	102,749	90,094	148,450	158,621
Connecticut	(a)	(a)	(a)	(a)	(a)	(a)
Delaware					4,203	26,508
Florida					(a)	(a)
Georgia			130,925	131,777	233,828	850,072
Idaho					394	2,410
Illinois	30,154	49,188	568	568	130,323	242,487
Indiana	(a)	(a)	5,089	12,173	45,446	74,288
Iowa			22,887	23,068	22,887	23,068
Kentucky			(a)	(a)	67,591	270,858
Maryland	(a)	(a)	55,950	84,425	72,749	147,969
Massachusetts			59	237	1,012	3,941
Michigan			1,653	4,852	1,653	4,852
Minnesota			19,078	25,287	19,078	25,287
Mississippi					1,080	2,160
Missouri	1,250	1,859			412,128	1,238,622
Montana			3,933	6,000	7,363	11,416
Nebraska					248	890
Nevada			(a)	(a)	(a)	(a)
New Jersey	10,008	41,256	49,798	119,791	313,360	1,206,947
New Mexico					1,681	6,542
New York			5,852	19,223	5,976	20,463
North Carolina	10	10	60	60	14,656	214,622
North Dakota					45	474
Ohio	31,265	46,076	20,718	40,552	235,684	448,677
Oregon	399	1,496	2,889	8,031	3,288	9,527
Pennsylvania	1,868	2,906	44,401	70,016	381,259	1,306,253
South Carolina			50	50	53,577	416,725
South Dakota			100	1,000	100	1,000
Tennessee	20	110	429	964	74,114	362,281
Texas	50	75			3,554	22,601
Utah			1,528	3,570	4,567	20,754
Vermont					(a)	(a)
Virginia			(a)	(a)	13,810	113,828
Washington			455	1,966	6,136	14,745
West Virginia					58,692	94,371
Wisconsin			230	748	230	748
Wyoming			466	7,313	466	7,313
Undistributed	570	1,510	1,187	3,247	40,633	531,380
	86,866	164,870	[d] 529,147	[d] 745,186	2,647,700	8,330,514
Average price per ton		1.90				3.15

[a] Included under "Undistributed."

[c] Includes ardmorite, bentonite, shale, clay for art pottery, asbestos products, blast furnaces, brick, cement, decolorizing oils, drain tile, fireworks, foundries, high-grade tile, hollow ware, modeling, paint, plaster and its products, red earthenware, roofing tile, sewer pipe, stove polish, and terra cotta. Slip clay is also included in this column as a matter of convenience.

[d] These totals include 4,050 tons of slip clay, valued at $19,405, or $4.79 per ton, from Michigan (420 tons, valued at $2,162) and New York (3,630 tons, valued at $17,243).

Forty-one States reported clay sold as such in 1922. The five leading States, in the order of quantity sold, were Missouri (16 per cent of total for United States), Pennsylvania (14 per cent), New Jersey (12 per cent), Ohio (9 per cent), and Georgia (9 per cent). In all these States except Georgia fire clay is the leading variety reported, constituting 99 per cent of the output in Missouri, 76 per cent in Pennsylvania, and 78 per cent in New Jersey and Ohio.

PRODUCTION BY USES.

Statistics showing the production of clay by uses are necessarily incomplete, as many clay miners do not know the purposes to which their clay is put, but it is believed that the figures given in the following table are sufficiently complete to serve as a guide in the study of the uses of domestic clays. In considering these figures it should be borne in mind that they represent chiefly the clay sold as clay by the original producers and do not include the much greater quantities of clay that are burned into clay products by those who mine their own clay:

Clay sold in the United States in 1922, by uses and kinds, in short tons.

Use.	Kaolin, china clay, and paper clay.	Ball clay.	Slip clay.	Fire clay (including fire-clay dust).	Stoneware clay.	Miscellaneous clay.	Total.
White-bodied ware made from white-burning clays, including china, general ware, chemical porcelain, porcelain electrical supplies, sanitary ware, etc	52,047	32,285	.....	14,925	.....	.....	99,257
Art pottery	531	877	.....	904	600	381	3,293
High-grade tile	19,534	18,338	.....	10,114	.....	250	48,236
Chemical stoneware	.....	.....	.....	798	2,423	.....	3,221
Stoneware	412	736	.....	558	78,069	80	79,855
Enameling, as coating for granite ware, etc	120	900	110	955	.....	.....	2,085
Paper filler	104,403	.....	.....	1,206	.....	.....	105,609
Paper coating	10,243	.....	.....	963	.....	.....	10,243
Rubber	13,779	.....	.....	.....	.....	.....	14,742
Oilcloth or linoleum	8,008	.....	.....	.....	.....	.....	8,008
Paint filler or extender	14,457	.....	.....	692	.....	774	15,923
Paint pigment	280	.....	.....	.....	.....	78	358
Architectural terra cotta	101	2,822	.....	57,237	1,400	17,963	79,523
Asbestos products	267	400	.....	10,860	.....	3,604	15,131
Plaster and plaster products	4,038	.....	.....	6,165	.....	2,357	12,560
Slip for glazing purposes	.....	.....	1,585	.....	.....	.....	1,585
Kalsomine	2,824	.....	.....	46	.....	.....	2,870
Artificial abrasives	10	160	2,355	984	.....	.....	3,509
Crayons (for tailors' use, etc.)	505	.....	.....	.....	.....	.....	505
Chemicals	1,093	.....	.....	.....	.....	5	1,098
Pencil leads (graphite)	50	.....	.....	.....	.....	.....	50
Saggers	6,752	14,335	.....	93,900	1,689	7,767	124,443
Pins, stilts, and spurs for potters' use	281	264	.....	1,998	.....	.....	2,543
Wads	.....	1,214	.....	24,828	.....	.....	26,042
Gas retorts	.....	.....	.....	617	429	.....	1,046
Fire brick and block	2,362	248	.....	512,792	358	.....	515,760
Fire-clay mortar, including clay processed for laying fire brick	.....	.....	.....	314,586	.....	.....	314,586
Bauxite and high alumina brick	.....	.....	.....	3,943	.....	.....	3,943
Glasshouse pots	210	536	.....	15,520	.....	234	16,500
Glasshouse supplies, blocks, tiles, etc	90	.....	.....	19,625	.....	.....	19,715
Zinc retorts	.....	.....	.....	19,175	.....	.....	19,175
Zinc condensers	.....	.....	.....	15,646	.....	.....	15,646
Clay crucibles	231	.....	.....	987	.....	.....	1,218
Foundry use and steel works for cupola lining, etc	538	.....	.....	340,981	100	43,568	385,187
Unspecified [a]	32,509	3,677	.....	208,215	1,798	448,036	694,235
	275,675	76,792	4,050	1,679,220	86,866	525,097	2,647,700

[a] Includes clay for brick, cement, clarifying oils, gas-stove backs, hollow ware, ink, matches, modeling, peanut coating, phonograph records, red earthenware, refractory cement, roofing tile, sewer pipe, soap, stove lining, stove polish, tanning, and wall paper.

IMPORTS AND EXPORTS.[3]

Clay imported and entered for consumption in the United States, 1913–1922.

Year.	Kaolin or china clay.			Common blue and Gross Almerode glass-pot clay.		All other clays.				Total.	
						Unwrought.		Wrought.			
	Short tons.	Value.	Average price.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1913..	268,666	$1,623,993	$6.04	24,986	$204,911	42,582	$155,693	1,889	$22,178	338,123	$2,006,775
1914..	328,038	1,927,425	5.88	16,761	122,325	50,069	195,956	3,232	41,712	398,100	2,287,418
1915..	209,132	1,152,778	5.51	8,864	62,569	23,718	90,367	1,343	12,433	243,057	1,318,147
1916..	253,707	1,326,684	5.23	2,501	12,134	42,478	163,421	180	1,994	298,866	1,504,233
1917..	241,029	1,315,769	5.46	88	709	26,581	123,439	338	2,142	268,036	1,442,059
1918..	168,100	1,153,240	6.86	114	983	26,984	163,484	137	1,087	195,335	1,318,794
1919..	180,592	1,965,393	10.88	4	133	23,759	187,550	498	4,262	204,853	2,157,338
1920..	361,800	3,568,677	9.86	6,837	157,201	34,252	272,524	691	10,267	403,580	4,008,669
1921..	162,906	1,546,285	9.49	4,468	77,217	41,421	348,870	120	2,313	208,915	1,974,685
1922..	310,136	2,963,420	9.56	7,323	84,415	30,643	246,807	2,468	27,233	350,570	3,321,875

Clay exported from the United States, 1916–1922.

Year.	Kaolin, china clay, and paper clay.		Fire clay.		All other.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1916.....	(a)	(a)	45,752	$144,552	27,941	$145,970	73,693	$290,522
1917.....	(a)	(a)	54,023	268,093	29,194	178,764	83,217	446,857
1918.....	(a)	(a)	60,206	333,880	24,348	192,053	84,554	525,933
1919.....	(a)	(a)	37,486	262,501	30,983	249,571	68,469	512,072
1920.....	(a)	(a)	54,125	393,177	66,035	775,222	120,160	1,168,399
1921.....	(a)	(a)	23,666	177,979	23,779	183,449	47,445	361,428
1922.....	2,091	$27,840	24,391	169,664	21,194	240,068	47,676	437,572

[a] Not separately classified prior to 1922.

[3] Figures of imports and exports compiled by J. A. Dorsey, of the U. S. Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

TALC AND SOAPSTONE.

By Edward Sampson.[1]

PRODUCTION.

GENERAL SUMMARY.

The talc industry made a notable recovery in 1922. The sales of talc and soapstone nearly reached 200,000 tons, which was about the average for 1915–1920. This record is particularly encouraging,

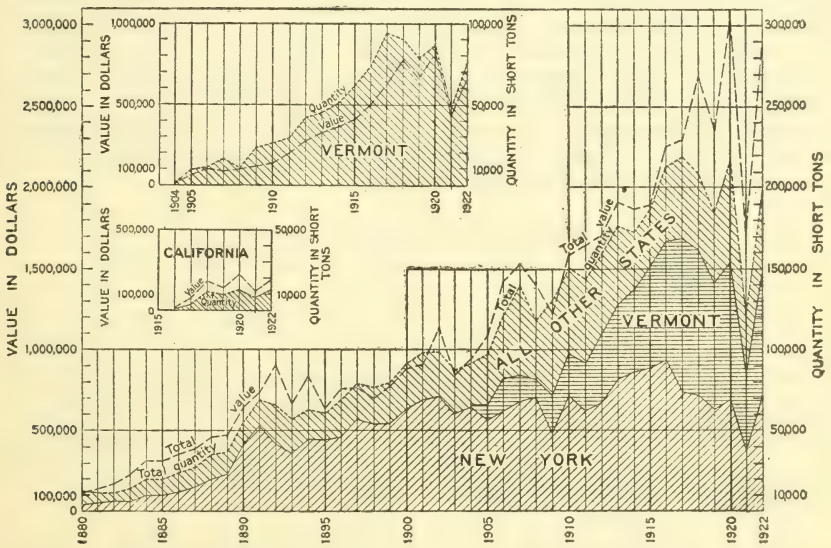

FIGURE 3.—Talc and soapstone produced in the United States, 1880–1922.

as the depression of 1921 lasted into the early part of 1922. The total sales showed an increase of 63 per cent in both quantity and value over 1921, and the quantity was 94 per cent of that in 1920. Exclusive of manufactured products of talc and of soapstone the sales in 1922 were 93 per cent of those in 1920. The relation of the figures for 1922 to those for earlier years is shown in Figure 3.

[1] The figures showing the domestic output have been compiled by Miss B. H. Stoddard, those showing imports by J. A. Dorsey from the records of the Bureau of Foreign and Domestic Commerce, and those showing foreign production by Miss W. I. Whiteside.

Talc and soapstone mined and sold in the United States, 1918–1922.

Year.	Crude.		Sawed and manufactured.				Ground.		Total.	
			Talc.		Soapstone.					
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1918	17,633	$193,278	1,075	$116,952	12,330	$501,059	177,269	$1,869,730	208,307	$2,681,019
1919	15,625	73,437	921	147,339	16,504	530,163	151,793	1,601,736	184,843	2,352,675
1920	11,008	43,820	1,415	139,335	19,707	709,400	178,505	2,142,894	210,635	3,035,449
1921	2,150	12,911	(a)	(a)	[b]17,423	[b]627,826	[c]102,413	[c]1,115,205	[c]121,986	[c]1,755,942
1922	4,981	22,582	654	86,333	22,700	712,144	170,349	2,038,838	198,684	2,859,897

[a] Included under "Soapstone."
[b] Includes some sawed and manufactured talc.
[c] Revised figures.

The sales of the several grades of talc and soapstone are shown in the above table. Practically all talc sold in the crude state by producers is eventually ground, but as figures are collected only from producers the value of this material after grinding is unknown.

In the 1921 report figures were given on consumption of ground talc by the industries. It has not been possible to compile such figures for 1922, because of the refusal of the International Pulp Co. to furnish the necessary information. All other companies have furnished carefully prepared data, but the output of this company is so great as to affect the total markedly. For 1921 an estimate was made for this company, but for 1922 information for such an estimate is not at hand. The total figures for 1921 are probably low for the minor uses, particularly talcum powder.

Producers of talc and soapstone in 1922.

Name and address.	Location of mine.
CALIFORNIA.	
Wallace W. Hite, Tecopa	½ mile south of Acme station, San Bernardino County.
W. S. McLean, 932 Monadnock Building, San Francisco.	Near Latrobe, Eldorado County.
G. W. Morton, Elsinore	
Pacific Coast Talc Co., 2149 Bay Street, Los Angeles	7 miles north of Silver Lake station, San Bernardino County.
Russi Soapstone Co., Folsom	1½ miles from Shingle station, Eldorado County.
Sierra Talc Co., 401 Equitable Bank Building, Los Angeles.	18 miles from Keeler, Inyo County.
GEORGIA.	
Georgia Talc Co. (Inc.), Asheville, N. C	Foot of Cohutta Mountain, 3½ miles southeast of Chatsworth, Murray County.
MARYLAND.	
Harford Talc Co., 2222 Mount Holly Street, Baltimore.	Near Dublin, Harford County.
Maryland Mineral Co. (Inc.), Conowingo	Conowingo, Cecil County.
Herbert I. Oursler, Marriottsville	¼ mile west of Henryton, Carroll County.
NEW JERSEY.	
Rock Products Co., 403 Trust Building, Easton, Pa	Above Marble Hill, on Delaware River, near Phillipsburg, Warren County.
NEW YORK.	
Carbola Chemical Co. (Inc.), 299 Ely Avenue, Long Island City.	1½ miles from Natural Bridge, Lewis County
International Pulp Co., 41 Park Row, New York City.	Talcville, St. Lawrence County.
W. H. Loomis Talc Corporation, 173 East Main Street, Gouverneur.	Fowler, St. Lawrence County.

Producers of talc and soapstone in 1922—Continued.

Name and address.	Location of mine.
NORTH CAROLINA.	
Georgia Talc Co., Asheville	On Big Laurel Creek, 9 miles north of Marshall, Madison County.
Standard Mineral Co. (Inc.), 1328 Broadway, New York, N. Y.	2½ miles from Hemp, Moore County.
PENNSYLVANIA.	
J. O. Wagner & Co., 520 McCartney Street, Easton	On Bushkill Creek, 3 miles above Easton, Northampton County.
C. K. Williams & Co., 640 North Thirteenth Street, Easton.	Near Easton, Northampton County.
VERMONT.	
American Mineral Co., Johnson	Johnson, Lamoille County.
American Soapstone Finish Co., Chester	Chester, Windsor County.
Eastern Talc Co., 45 Milk Street, Boston, Mass	East Granville, Addison County, and Rochester Windsor County.
Magnesia Talc Co., Waterbury	Waterbury, Washington County.
Vermont Talc Co., Chester	Windham, Windham County.
VIRGINIA.	
Blue Ridge Talc Co. (Inc.), Henry	¾ mile east of Henry station, Franklin County.
Bull Run Talc & Soapstone Co., Clifton Station	3 miles north of Clifton, Fairfax County.
Virginia Alberene Corporation, 153 West Twenty-third Street, New York, N. Y.	Schuyler, Nelson County.

PRODUCTION BY STATES.

Talc and soapstone mined and sold in the United States, 1920–1922, by States.

State.	1920		1921		1922			Percentage of increase in 1922.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Per cent of total quantity.	Quantity.	Value.
Vermont	86,489	$816,794	48,648	$438,534	75,485	$654,715	38	55	49
New York	68,168	977,228	[a]37,489	[a]464,645	71,470	1,116,914	36	91	140
Virginia	21,715	729,767	17,721	601,878	25,351	736,132	13	43	22
California	13,199	232,182	8,233	128,188	12,638	187,011	6	54	46
Pennsylvania, New Jersey	11,183	121,302	7,205	76,912	8,373	87,367	4	16	14
North Carolina	2,267	75,474	731	17,048	2,194	23,049	1	200	35
Maryland	4,372	17,948	(b)	(b)	1,667	14,667	2	.....	.....
Other States [c]	3,242	64,754	1,959	28,737	1,506	40,042			
	210,635	3,035,449	[a]121,986	[a]1,755,942	198,684	2,859,897	100	63	63

[a] Revised figures.
[b] Included under "Other States."
[c] 1920 and 1921: Georgia, Massachusetts; 1922: Georgia.

California.—The above table shows the summary figures for the California talc industry for the last three years. The total production of the State since the beginning of mining is shown in Figure 3. Six producers shipped talc in 1922. The Sierra Talc Co., formerly the Inyo Talc Co., and the Pacific Coast Talc Co. each milled a high-grade talc. The other shippers all marketed crude talc. C. S. Swift shipped from Latrobe, in Eldorado County, and G. W. Morton and the American Talc Co. made small shipments from Acme, in San Bernardino County.

Georgia.—The Georgia Talc Co. was the only company operating in Georgia in 1922. Its principal activity was the manufacture of crayons.

Maryland.—The Harford Talc Co. pushed operations vigorously in 1922 at its mine near Dublin, Md. Herbert I. Oursler continued to ship talc schist from Henryton, and the Maryland Mineral Co. resumed operations in a small way near Conowingo and also shipped crude talc.

Massachusetts.—Operations in the Rowe district, Mass., were suspended entirely in 1922.

New Jersey and Pennsylvania.—In the Easton-Phillipsburg district of New Jersey and Pennsylvania operations continued as usual.

New York.—Three companies furnish the entire New York supply. The International Pulp Co. has completed a hydroelectric installation and made improvements to its mill so that it now produces a very high-grade product. The W. H. Loomis Talc Corporation greatly increased its output by the addition of new machinery. One unit of its mill in 1922 produced 325-mesh double air-floated talc. The company is building a new steel mill at York siding, Emeryville, and reports that it will begin operations in the summer of 1923 with a capacity of 25 tons a day of 325-mesh talc. The finished mill will have a capacity of 100 tons a day. New storage bins were constructed at the present mill, and improvements were made in mining equipment.

The Carbola Chemical Co. continued actively its operations at Natural Bridge. The mine and mill operated under lease by the Uniform Fibrous Talc Co. have been sold to F. A. Stoughton, of Potsdam.

North Carolina.—An important development in the South has been the expansion of operations by the Standard Mineral Co., which mines pyrophyllite near Hemp, in Moore County, N. C. This company has greatly increased its output of ground "talc." The Georgia Talc Co., also mining pyrophyllite, continued operations near Marshall, its output being principally crayons. The Talc Products Co., which has produced for a number of years, suspended operations throughout 1922.

Vermont.—The Vermont talc industry showed an increase of 55 per cent in volume of business, with a corresponding lowering of prices. The producers were the same as in 1921.

Virginia.—The talc and soapstone output of Virginia in 1922 was the greatest on record, owing largely to the activity of the Virginia Alberene Corporation. This organization, whose selling branch is the Alberene Stone Co., is the only producer of manufactured soapstone. The Blue Ridge Talc Co. greatly increased its production of ground talc. The Bull Run Talc & Soapstone Co. increased its sales of ground talc, which is said to be of a very superior grade for foundry facings. In 1922 the Charlottesville Soapstone Corporation, of Charlottesville, was formed. This company has acquired a property near Esmont station of the Chesapeake & Ohio Railway. In 1922 necessary machinery for quarrying and for cutting slabs was purchased and stripping was carried out preliminary to active quarrying.

WORLD'S PRODUCTION.

World's production of talc and soapstone, 1918–1922, by countries, in metric tons.

Country.	1918	1919	1920	1921	1922
Argentina [a]	(b)	(b)	20	(b)	(b)
Australia:					
New South Wales [c]	365	364	214	61	203
South Australia [d]	315	268	201	262	(b)
Austria	(b)	(b)	(b)	(b)	(b)
Canada [e]	16,483	16,912	19,659	9,184	12,300
Egypt [f]	137	.....	.....	.....	(b)
France [g]	(g)	35,600	(b)	34,742	(b)
Germany (Bavaria) [h]	9,308	5,371	20,943	6,619	(b)
India [i]	13,191	2,169	3,740	5,745	(b)
Italy [j]	18,111	17,550	21,475	21,031	25,000
Norway [k]	15	2,988	.....	2,810	(b)
Spain [l]	3,328	3,024	2,146	1,115	3,078
Sweden [m]	(b)	(b)	(b)	1,797	(b)
Union of South Africa: [n]					
Natal	11	(b)	.....	.....	(b)
Transvaal	597	687	619	375	(b)
United Kingdom [o]	951	699	367	.....	(b)
United States	188,972	167,686	191,084	110,663	180,242

[a] Data furnished by Dirección general de minas, geología é hidrología, Argentina.
[b] Figures not yet available.
[c] New South Wales Dept. Mines, Ann. Repts.
[d] South Australia Dept. Mines, Rev. Mining Operations.
[e] Canada Dept. Mines, Mines Branch, Ann. Repts.
[f] Mines and Quarries Dept.: Ministry of Finance.
[g] 1919: Statistique de l'industrie minérale en France. 1921: Ministry of Public Works. Statistics from 1914–1918 not separately recorded.
[h] 1918 and 1921: Glückauf. 1919–20: Consular rept., Mar. 18, 1922.
[i] India Geol. Survey Rec.
[j] Rivista del servizio minerario.
[k] Norges Offisielle Statistikk, Norges Bergverksdrift.
[l] Estadistica minera de España.
[m] Bergshantering. Figure for 1921 does not include an apparently small amount for which only value is given.
[n] Ann. Repts. Government Mining Engineer, Union of South Africa, Dept. Mines.
[o] 1918–1920: Mines and quarries. 1921: Ann. Rept. Sec. Mines and H. M. Chief Inspector Mines.

The production of talc and soapstone in foreign countries is shown in the above table, so far as published information is available. It is not possible to give exact figures of the total world's production, but sufficient material is at hand to warrant some estimates. For recent years the greatest cause of uncertainty is the production of Austria. The mines of the Mautern district in Styria have been in operation for over a hundred years, and there is a large industry dependent on them. The exports from Austria have been as follows in metric tons: 1913, 8,080; 1921, 8,031; 1922, 13,480. Besides the exported talc a large amount is used in domestic industries, the paper industry in particular. J. S. Diller estimated the output for 1913 at about 16,000 tons. Figures for France are not available for 1920 and 1922, but as 60,175 tons was produced in 1913 the figures given in the table for 1919 and 1921 evidently do not represent the normal capacity. In Germany the output has greatly increased in the period included in the table for which figures are available. The German capacity seems to be at least 15,000 tons.

Taking these factors into consideration and estimating 16,000 tons for Austria in 1913, 67,000 tons for the missing countries in 1920, and 86,000 tons for the missing countries in 1922, we obtain the following approximate totals: 1913, 280,000; 1920, 327,000; 1922, 307,000. The figure for 1920 is probably abnormal, owing to the overproduction in this country. It seems probable that the world's capacity for consumption was about 280,000 tons in 1913 and is now about 310,000 tons. Two-thirds of this increase is due to the increased consuming capacity of the United States. As figured from the above totals, the United States produced 57 per cent of the world's total in 1913, 58 per cent in 1920, and 59 per cent in 1922.

IMPORTS AND EXPORTS.

Talc imported for consumption in the United States, 1918–1922.

Year.	Crude and unground steatite and French chalk.[a]			Talc, steatite, and French chalk—cut, ground, or washed.[b]			Total.	
	Short tons.	Value.		Short tons.	Value.		Short tons.	Value.
		Total.	Average.		Total.	Average.		
1918	1,434	$9,253	$6.45	12,735	$251,323	$19.73	14,169	$260,576
1919	1,641	10,105	6.16	12,961	248,899	19.20	14,602	259,004
1920	941	7,206	7.57	21,739	443,514	20.40	22,680	450,720
1921	153	2,279	14.90	11,468	239,469	20.88	11,621	241,748
1922	248	9,850	40.00	[c] 14,220	[c] 278,254	[c] 19.57	[d] 18,444	[d] 377,378

[a] To Sept. 21, 1922, duty free; after Sept. 21 duty was ¼ cent a pound.
[b] 15 per cent duty to Sept. 21, 1922.
[c] Jan. 1 to Sept. 21.
[d] Totals include, in addition to items shown, the following imports of talc in 1922 after the new tariff went into effect, Sept. 22: "Ground, washed, powdered, or pulverized (except toilet preparations)," 3,964 tons, $86,707 (duty of 25 per cent ad valorem); "cut or sawed, or in blanks, crayons, cubes, disks, or other forms," 12 tons, $2,134 (duty of 1 cent a pound); "manufactures (except toilet preparations) wholly or partly finished, not decorated," 138 pounds, $109 (duty of 35 per cent ad valorem); "manufactures (except toilet preparations) wholly or partly finished, decorated," 1,411 pounds, $324 (duty of 45 per cent ad valorem).

The imports of talc in 1922 were about the average of those since 1915. The new tariff had little effect upon the amount of talc imported, the total imports coming at practically the same average rate before and after September 22, when the new schedule went into effect. The new and old tariff classification and rates are shown in the above table. The rate on toilet preparations is 75 per cent ad valorem. The quantity of this grade of talc can not be determined from the published data, owing to grouping with other commodities. The sources of imported talc are shown in the following table:

General imports of talc, ground or unground, into the United States, 1918–1922, in short tons.

Country.	1918	1919	1920	1921	1922		
					Quantity.	Value in country of origin.	
						Total.	Average.
Austria			22	361	297	$12,916	$43.49
Belgium					20	128	6.40
Canada	12,185	11,852	15,123	6,993	9,928	149,747	15.08
China					1	441	441.00
Denmark			11				
England			34	72	2	387	193.50
France	22	163	1,834	1,031	2,528	46,702	18.47
French Africa			22				
Germany			2	1	[a]	24	
Hongkong					[a]	1	
India			1	1	15	700	46.67
Ireland				[a]			
Italy	490	958	4,619	2,969	5,470	160,211	29.29
Jamaica			33		30	274	9.13
Kwangtung (leased territory)				[a]			
Norway					11	97	8.82
Other British West Indies			28				
Sweden			[a]				
Switzerland				28	[a]	56	
	12,697	12,973	21,729	11,456	18,302	371,684	20.31

[a] Less than 1 ton.

Exports of talc in bulk are not recorded. The exports of "talcum and other toilet powders" in 1922 amounted to 1,821 tons, valued at $1,397,542.

POTASH.[1]

By George Rogers Mansfield.[2]

INTRODUCTION.

In the fall of 1921, as noted in Mineral Resources for that year, 34 American fertilizer manufacturers entered into contracts with the German Kali Syndicate and with French potash producers to supply all the potash they needed, at prices lower than pre-war figures and under conditions especially arranged to meet competition from American sources. This was a disheartening experience for American potash producers, but the contracts mentioned were to expire in April, 1922, and the producers looked forward to a moderate and graduated protection under the pending tariff legislation. The contracts were not renewed, but in the tariff law that went into effect September 22, 1922, potash was placed on the free list. Thus the year 1922 was one of uncertainty in the American potash industry and was marked by a further reduction in the number of producing plants, but the production of K_2O was slightly greater than that of the preceding year.

Further discoveries of potash were made in the course of deep drilling for oil in western Texas, and stock-promotion schemes based on these discoveries were floated with more or less success. No specific information was gained, however, about the thickness, quality, and quantity of the potash. A more detailed statement regarding these discoveries and the activity of the Geological Survey in relation to them is given on pages 95–98.

PRODUCTION AND SALES.

In 1922 nine companies operating twelve plants produced 25,176 short tons of crude material containing an average of 46.5 per cent of K_2O. The sources of this material are stated in the table. No production was reported from alunite, silicate rocks, kelp, wool washings, or Nebraska or Utah salines. The only companies that

[1] Since 1910 a chapter on potash has appeared annually in Mineral Resources of the United States. Extensive bibliographies and lists of United States patents covering processes for the extraction of potash from silicate rocks have been included in most of these chapters. The chapter for 1910 contained a brief account of the German potash deposits, the chapter for 1915 gave simple tests for potash, those for 1916 and 1917 included descriptions of the sources of potash in this country and brief statements concerning efforts to produce potash from other sources, and the chapter for 1918 included descriptions of refined potassium salts.

[2] Miss Leona Boardman has kindly compiled the statistical data, except the tables of imports and exports, which have been prepared by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce. Miss Boardman has also helped in the preparation of other parts of the report.

reported continuous operation of their potash plants throughout the year produced their material as a by-product in the manufacture of salt, cement, steel, and alcohol; other companies reported activities ranging from one to nine months.

Although the production above reported was 1 per cent less than in 1921, the available content of K_2O was 15 per cent greater, and the value of the material sold at the point of shipment was 3 per cent greater. The average value per unit (20 pounds of K_2O) was 41 cents.

A number of companies that were not producing in 1922 reported stocks or sales. These are included in the table.

Potash produced and sold in the United States in 1922, by sources.

	Organic.		Mineral (natural brines, dust from cement mills, and dust from blast furnaces).	Total.
	Molasses distillery waste.	Steffens water from beet-sugar refineries.		
Production:				
Number of plants reporting	2	2	8	12
Crude potash (short tons)	6,581	304	18,291	25,176
Available content of K_2O:				
Short tons	2,299	96	9,319	11,714
Percentage of total	19.6	0.8	79.6	100
Sales:				
Number of plants reporting	1	6	9	16
Crude potash (short tons)	2	2,058	19,968	22,028
Available content of K_2O (short tons)	1	756	10,556	11,313
Value f. o. b. plant	$30	$49,441	$414,041	$463,512
Stocks on hand Dec. 31, 1922:				
Number of plants reporting	2	1	13	16
Crude potash (short tons)	12,203	100	17,797	30,100
Available content of K_2O (short tons)	4,267	30	7,356	11,653

A comparison of the figures of production for 1922 with those for previous years shows that more K_2O was produced in that year than in 1921 or in 1916. The banner year was 1918, when more than four times as much as in 1922 was produced.

Potash produced and sold in the United States, 1916–1922.

Year.	Number of plants.		Production.		Sales.[a]		
	Total.	Exclusive of producers of wood-ash potash.	Crude potash (short tons).	Available content of K_2O (short tons).	Crude potash (short tons).	Available content of K_2O (short tons).	Value f. o. b. plant.
1916	70	25	35,739	9,720	35,739	9,720	$4,242,730
1917	95	46	126,961	32,573	126,961	32,573	13,980,577
1918	128	77	207,686	54,803	140,343	38,580	15,839,618
1919	102	67	116,634	32,474	166,063	45,728	11,271,269
1920	66	49	166,834	48,077	139,963	41,444	7,463,026
1921	20	19	25,485	10,171	10,337	4,408	447,859
1922	12	12	25,176	11,714	22,028	11,313	463,512

[a] Production and sales were practically the same in 1916 and 1917, and no distinction was made between them.

The material sold consisted chiefly of chloride, with some sulphate and mixed salts, as shown in the following table. The content of K_2O was 11,313 short tons, as compared with 4,408 tons in 1921.

Domestic potash sold in the United States in 1921 and 1922, classified according to material sold.

Material sold.	Crude potash (short tons).	Available content of K_2O.		
		Per cent.	Short tons.	Percentage of total.
1921.				
Crude mixed salts	4,432	25–42	1,517	34.4
High-grade chloride	5,028	50–58.7	2,741	62.2
Dust from cement mills and blast furnaces	657	1.8–11.2	52	1.2
All other [a]	220	29–51	98	2.2
	10,337	.....	4,408	100.0
1922.				
Chloride	17,313	29–57	9,526	84.2
Sulphate	1,683	8–33	521	4.6
Mixed salts	3,032	25–55	1,266	11.2
	22,028	.....	11,313	100.0

[a] Includes sulphate, low-grade chloride, and crude caustic.

In only two States was potash produced in 1922 in more than two plants. California was the leading producer; Maryland was second. The figures for Pennsylvania and Porto Rico are combined in order to avoid revealing confidential information.

Potash produced in the United States in 1922, by States.

	Number of plants.	Crude potash (short tons).	Available content of K_2O.	
			Short tons.	Percentage of total.
California	4	17,551	9,363	79.9
Maryland	1	6,535	2,287	19.5
Indiana	1	100	30	.3
Pennsylvania	5	990	34	.3
Porto Rico	1			
	12	25,176	11,714	100.0

GOVERNMENT ACTIVITIES.

United States Geological Survey.—The potash investigations of the Geological Survey have been largely confined to the study of the newly discovered field in western Texas, though there has been correspondence regarding other occurrences of potash and some laboratory tests have been made. The discontinuance of active cooperation by the Bureau of Economic Geology and Technology of the University of Texas, necessitated by the withdrawal of legislative support, left the Geological Survey as the only official body engaged in the exploration of this field. H. W. Hoots, who had charge of the work through the first half of the year, left in September to resume

university studies and was succeeded by W. B. Lang. The Survey headquarters were transferred from Big Spring to Midland, in Midland County. A brief account of the western Texas potash field is given on pages 95–98.

Bureau of Mines and Bureau of Soils.—No active work on potash was done in the Bureau of Mines or the Bureau of Soils during 1922, though the developments in the United States and abroad have been closely watched.

W. H. Ross, of the Bureau of Soils, reports that investigations relating to the recovery of potash from blast furnaces, which he has had in progress for several years, have been completed and a report is now in press.

W. J. Turrentine, who is now in charge of the potash investigations of the Bureau of Soils, in a letter to the writer, summarizes the potash situation as follows:

> The past activities in connection with American potash may be divided into three periods. During the period beginning in 1910 and ending with the inauguration of the European war in 1914 the Government's potash work had to do principally with reconnaissance surveys of the United States for possible sources of potash. The succeeding period, represented by the four years of the European war, was devoted to the active development by private interests of practically all the sources of potash discovered and surveyed by the Government. The third period, represented by the time that has elapsed since the termination of the European war, has been one during which the complete deflation * * * of the potash industry has taken place, during which all of the potash industries established during the preceding period have been subjected to the most trying economic test to see whether or not the processes they employed are feasible for peace-time conditions.
>
> With such a background of large-scale investigations—surveys, experimentation, and economic and industrial try-outs—we are now in an excellent position to proceed with a comprehensive investigation of America's resources in potash. We have at our disposal such a tremendous fund of information that we can now proceed with a great deal of assurance, knowing definitely what the problems are and in what rests their solution.
>
> Among the conclusions we have been able to make is the definite one that any potash produced from present American sources must be produced as a by-product if it is to compete with foreign potash. The reason is obvious—that it must be produced at a lower cost than it can be if produced alone from any of the raw materials so far exploited. Therefore, it is proposed to investigate the potash problem from the viewpoint of obtaining with the potash other products of commercial value.
>
> Each raw material constitutes a distinct problem. These may be listed as follows: Cement dust, blast-furnace dust, alunite, leucite, glauconite, sugar-refinery and distillery waste.

IMPORTS AND EXPORTS.

The imports of potash materials for 1922 are shown in the following table. In 1913, the last normal year before the war, the United States imported, chiefly from Germany, 270,720 short tons of K_2O. In 1921 the total imports were less than a third of that amount. In 1922, however, the importations rose to about 74 per cent of the amount for 1913 and were only 3 per cent less than in 1914.

Potash materials imported and entered for consumption in the United States, 1913, 1921, and 1922.[a]

Material.	Approximate K_2O content (per cent).	1913				1921				1922			
		Short tons.	Available content of K_2O.		Value.	Short tons.	Available content of K_2O.		Value.	Short tons.	Available content of K_2O.		Value.
			Short tons.	Percentage of total.			Short tons.	Percentage of total.			Short tons.	Percentage of total.	
Used principally in fertilizers:													
Kainite	12.4	521,176	64,626	23.9	$2,201,730	77,365	9,593	12.2	$1,453,854	169,287	20,992	10.4	$1,087,895
Manure salts	20.0	250,529	50,106	18.5	2,245,509	43,286	8,657	11.0	792,601	218,406	43,681	21.7	1,948,608
Muriate	50.0	237,630	118,815	43.8	7,075,745	79,642	39,821	50.6	4,777,726	179,484	89,742	44.6	5,485,287
Sulphate	48.6	44,349	21,554	8.0	1,677,429	12,459	6,055	7.7	719,183	65,534	31,849	15.8	2,429,407
		1,053,684	255,101	94.2	13,200,413	212,752	64,126	81.5	7,743,364	632,711	186,264	92.5	10,951,197
Used principally in chemical industries:													
Bicarbonate	46.0	223	103	.....	20,968	197	91	.1	33,352	323	149	.1	32,865
Bitartrate (argol)	20.0	14,499	2,900	1.1	2,779,180	8,089	1,618	2.1	1,189,902	11,483	2,297	1.1	1,709,184
Bitartrate (cream of tartar)	25.0	75	19	.....	28,314	669	167	.2	306,674	1,042	260	.1	395,746
Carbonate, crude	61.0	4,858	2,963	1.1	272,973	2,024	1,235	1.6	191,265	2,901	1,770	.9	287,172
Carbonate, crude or black salts	50.0	344	172	.1	17,852	1,665	833	1.1	76,091	1,839	920	.5	68,856
Carbonate, refined	67.0	6,145	4,117	1.5	393,284	70	47	.1	14,952	237	159	.1	27,909
Caustic	80.0	4,324	3,459	1.3	342,056	5,455	4,364	5.5	487,182	6,774	5,419	2.7	759,673
Chlorate	38.0	596	226	.1	64,468	2,771	1,053	1.3	246,191	3,855	1,465	.7	300,576
Chromate and bichromate	40.0	9	4	.....	1,819	37	14	.....	6,772	4	2	.....	1,676
Cyanide	70.0	735	514	.2	216,844	1,886	1,320	1.7	319,683	1,544	1,081	.5	253,072
Ferricyanide (red prussiate)	42.0	34	14	.....	12,035	13	5	.....	4,878	38	16	.....	40,324
Ferrocyanide (yellow prussiate)	44.0	1,706	751	.3	388,379	224	99	.1	91,447	385	169	.1	184,317
Iodide	28.0	.....	.....	.....	.....	.....	.....	.....	580	.....	.....	.....	21
Nitrate (saltpeter), crude	40.0	4,826	193	.1	261,078	8,297	3,319	4.2	590,200	2,730	1,092	.5	141,521
Nitrate (saltpeter), refined	46.0	203	93	.....	22,602	670	308	.4	45,548	401	184	.1	49,233
Permanganate	29.0	273	79	.....	38,188	192	56	.1	72,232	391	113	.1	89,456
Rochelle salt	22.0	54	12	.....	13,412	194	43	.....	62,141	251	55	.....	74,290
		38,904	15,619	5.8	4,873,452	32,453	14,572	18.5	3,739,090	34,198	15,151	7.5	4,415,891
Grand total	.....	1,092,588	270,720	100.0	18,073,865	245,205	78,698	100.0	11,482,454	666,909	201,415	100.0	15,367,088

[a] The figures in this table were compiled from the records of the Bureau of Foreign and Domestic Commerce by recalculation from pounds to short tons and to actual potash (K_2O) and by giving the totals for calendar years instead of fiscal years. The tons are calculated to the nearest even unit, and the values are those given in the original records, so that the value given for a high-priced commodity received in small quantity may not be strictly applicable to the quantity given in tons. Furthermore, the values are those placed on the commodities by the shippers and represent the values at point of shipment and do not agree with market quotations in this country.

The first four salts listed in the foregoing table are produced chiefly in Germany and France; the other materials listed are manufactured potassium salts, more or less refined.

Potash (K_2O) imported for consumption in the United States, 1913–1922, in short tons.

1913	270,720	1918	7,957
1914	207,089	1919	39,619
1915	48,867	1920	224,792
1916	7,885	1921	78,698
1917	8,100	1922	201,415

Until 1915 practically all the potash brought into this country came from Germany; from 1916 to 1920 it came from many different countries; in 1921 and 1922 it came principally from Germany, France, and Belgium, though that from Belgium and also that from Canada doubtless originated in Germany and France. Unfortunately there is no authentic information at hand concerning the original source of these shipments.

Potash imported into the United States in 1922, in short tons.[a]

[The figures in parentheses in the column headings indicate percentage of K_2O.]

Country.	Muriate (50).	Sulphate (48.6).	Manure salts (20).	Kainite (12.4).	Bitartrate argols or wine lees (20).	Hydrate (80).	Carbonate (61).	Cyanide (70).	Nitrate of, or saltpeter, crude (40).	Ferrocyanide (44).	All other (50).	Total.	
												Short tons.	Value.
Germany	114,285	63,748	100,867	99,827	53	1,018	2,770	47	17	11	4,191	386,834	$8,190,466
France	49,311	560	84,546	60,697	3,922	4,393	636			7	942	205,014	3,931,407
Belgium	17,285		32,608	7,309		11	711			7	56	57,987	911,325
Italy					1,896						13	1,909	346,195
Canada	39	156	215		5	(b)	97	1,479			2	1,993	243,397
Spain					1,435						5	1,440	203,235
Czechoslovakia						1,188	159			22	71	1,440	201,573
Argentina					1,064						2	1,066	169,157
Portugal					1,209							1,209	160,522
Chile					304		(b)		2,350			2,654	149,008
Algeria and Tunis					1,555							1,555	141,705
Netherlands			168		11	41	245				41	198	704	114,573
Denmark											22	133	155	74,976
England	12		2				310	1	8		35	92	460	64,859
Finland												336	336	42,787
Sweden						170	17				25	212	27,082
British India										355		355	24,818
Scotland				7				17				24	11,043
Cuba		181										181	7,973
Greece					24							24	3,364
China					3							3	3,343
Norway											6	6	3,136
Switzerland					2		17				17	36	3,031
Turkey in Europe							29					29	2,338
Australia							11					11	1,740
Austria											1	1	571
Hongkong							2					2	406
	180,932	64,645	218,406	167,840	11,483	6,821	5,004	1,544	2,730	145	6,090	665,640	15,034,030
Content of potash (K_2O)	90,466	31,417	43,681	20,812	2,297	5,457	3,052	1,081	1,092	64	3,045	202,464	

[a] The figures in this table were compiled from the records of the Bureau of Foreign and Domestic Commerce by recalculation to short tons and to the actual potash (K_2O) and by giving the totals by the calendar year instead of the fiscal year. The tons are calculated to the nearest even unit. The data represent general imports and include both imports for immediate consumption and those going to warehouses, which may or may not be entered for consumption during the year. They differ slightly from the figures in the preceding table of imports, which represents imports for consumption.

[b] Less than 1 ton.

Potash materials in the form of refined potassium salts are exported to a greater or less extent from the United States. In 1922 the value of the salts thus exported was more than double the value of the potassium salts exported in 1921 but only about 22 per cent of the corresponding value for 1920, as shown in the following table:

Potassium salts exported from the United States, 1920–1922.

Salt.	1920		1921		1922		
	Short tons.	Value.	Short tons.	Value.	Gross weight, short tons.	K_2O, short tons.	Value.
Potassium chlorate	1,410	$445,243	188	$49,709	281	107	$51,066
Potassium bichromate	.....	3,116,772	.....	286,284	2,215	886	433,552
All other potassium salts					3,742	.....	296,378
	.....	3,562,015	.....	335,993	6,238	.....	780,996

AMERICAN POTASH INDUSTRY.

Historical sketch.—The potash industry in the United States probably began in the early days of the country. Notice of it was taken in census statistics as far back as 1850, when the value of the product amounted to $1,401,533. The potash was obtained by leaching wood ashes. From that date onward the industry declined steadily, especially after 1890, as cheap foreign potash came more and more into use, practically displacing the domestic product. Meanwhile the uses for potash and the demand had greatly increased.

In 1911 the Geological Survey began a systematic investigation of sources of potash in this country and the Bureau of Soils undertook similar cooperative and independent investigations. The results of this work have been set forth in previous volumes of Mineral Resources, beginning with that for 1910, and in occasional Geological Survey bulletins (see lists in earlier chapters).

With the shutting out of German supplies during the World War the production of potash in the United States became a matter of national importance, and practically all sources disclosed by the investigations mentioned were utilized. In 1915 a total of 1,090 tons of K_2O was produced in this country by 5 plants. Under the stimulus of urgent demand and high prices the industry moved rapidly forward, and in 1918, the banner year, there were 128 plants, with a production of 54,803 tons of K_2O.

The signing of the armistice checked the advance of the industry, and as a result of the lower prices that have since been obtainable plant after plant has been forced to close. By 1921 the number of plants producing had dropped to 20. In 1922 there were only 12.

The placing of potash on the free list in the recently enacted tariff law seemed like a death blow to anxious supporters of the industry. Nevertheless the industry has survived and bids fair to become permanent.

Present status.—Only one of the plants in which potash was the sole or principal product has survived, and this plant has a valuable

by-product. In the other surviving plants potash is a by-product. Owing to the present low prices of foreign potash there is little to induce even these producers to continue, except that it affords a means of saving at least part of their investment.

The American potash industry is therefore marking time. Meanwhile attention is being devoted principally to reducing the cost of production and to perfecting processes initiated before the slump came. If potash should be included in a revision of tariff schedules, a definite advance may be expected. If not, the industry probably has sufficient vitality to keep it alive for an indefinite period, especially if American fertilizer manufacturers are willing to cooperate.

Outlook.—If the American potash industry is to survive, it must do so on its merits. It must convince the buyer, principally the farmer, that its products are as good as foreign potash or better, and it must supply the potash at competitive prices. Any protection afforded by tariff legislation will be but a temporary expedient and should be limited in time, because nothing should be done to cause a permanent increase in the cost of fertilizer to the farmer.

Development in the recently discovered potash field in western Texas must await more detailed exploration by core drilling. The evidence thus far gained favors the view that deposits of commercial grade and quantity may be present in this field. Such deposits of natural soluble potash salts would undoubtedly play an important part in the future of the American potash industry.

Potash permits.—The Department of the Interior has announced that 245 prospecting permits, covering 575,170.72 acres, and 4 leases for potash production, covering 7,343.76 acres, were issued in California, Utah, Nevada, New Mexico, Arizona, Colorado, Montana, and Nebraska prior to May 31, 1923. This record indicates a healthy state of interest in potash on the part of potash prospectors and the public generally. In view, however, of the large investments already lost in the potash industry and of the precarious condition of the portion of the industry that still survives, it is well to exercise caution in undertaking further ventures in this field.

THE POTASH FIELD IN WESTERN TEXAS.

The search for potash in western Texas, which has been carried on by the United States Geological Survey in cooperation with the Bureau of Economic Geology and Technology of the University of Texas, has been hampered by lack of funds, by lack of interest on the part of drillers who were in search of oil rather than potash, by the necessity of dependence upon the results of wildcatting, and by the inadequacy of the methods employed in drilling for showing the quality and thickness of the potash beds encountered. Although the presence of potash is established, definite information is still lacking regarding the thickness, quality, and extent of individual beds, the location of the richest deposits, and the place where the potash may be exploited most conveniently and cheaply.

The geologic conditions in western Texas resemble in many ways those of the Stassfurt district in Germany, famous for its salt and potash. In both regions "red beds" of Permian age—including shale, sandstone, and limestone, with intercalated beds of salt,

gypsum, and anhydrite—are present. The geologic conditions in Texas are also similar to those in the Alsatian potash field, but in Alsace the beds are much younger. These resemblances have led geologists to believe that potash salts would sooner or later be found in Texas, especially as it has long been known that the salt beds of Texas are very thick, and it is inconceivable that everywhere throughout the salt-bearing area concentration by evaporation should have stopped short of the degree required for the precipitation of potash salts.

The geologic structure of the region, as mapped by Darton,[3] is that of a syncline or basin with axis trending nearly northeast. The Permian beds are not well exposed at the surface in the known potash-bearing region, so that information regarding their structure is derived chiefly from scattered wells. As data from such sources become more abundant it will doubtless be found that the relatively simple basin outlined by present information is modified by subordinate basins or folds. According to the structure indicated, the potash beds should be nearer the surface in the marginal areas of the basin and deeper toward the central part.

Earlier discoveries of potash.—The first discovery of potash in western Texas was made in 1912 by J. A. Udden, in brine taken from a depth of about 2,200 feet in a well at Spur, in Dickens County. This brine after standing was found to contain 5.4 per cent of potassium calculated as chloride. In 1915 crystals of red salt in material from a depth between 875 and 925 feet in a well at Boden, in Potter County, yielded 9.2 per cent of K_2O. In 1915 also red salt from a depth between 1,500 and 1,700 feet in the Miller well, in Randall County, assayed 6.1 per cent of K_2O, and some colorless particles from a depth greater than 1,700 feet in the same well were found to contain 10.5 per cent of K_2O.

Test boring by the United States Geological Survey.—In the winter of 1915–16 the United States Geological Survey began a test boring for potash at Cliffside, 6 miles northwest of Amarillo, in Potter County. This site was selected because it is almost on the axis of the salt basin, near two wells from which potash has been obtained, and it is readily accessible. After interruptions through lack of funds the well was completed in 1917 at a depth of 1,703 feet. Although salt beds aggregating more than 350 feet in thickness were penetrated, only insignificant amounts of potash were found in the brines, and no potash-bearing mineral was recognized. It was thought, however, that salt beds would have been encountered for at least an additional 350 feet had it been possible to continue drilling. Although no further test boring by the Survey has been practicable, an observer has been kept in the field to cooperate with drillers and to procure samples for analysis.

Results from wildcatting.—Since 1920 data of a more favorable nature have been accumulating as a result of observations at wildcat wells, and the mineral polyhalite ($MgSO_4.K_2SO_4.2CaSO_4.2H_2O$) has been recognized at a number of localities in an area at least 130 miles long and 80 miles or more wide. Of the seven wells that have thus far yielded information of this sort, three—the Bryant well,

[3] Darton, N. H., Permian salt deposits of the south-central United States: U. S. Geol. Survey Bull. 715, pp. 205–230, 1921.

in Midland County; the Burns well, in Dawson County; and the G. A. Jones well, in Borden County—have furnished no continuous record but only individual cuttings. The other four wells have supplied more or less continuous records for certain depths. These are the River well, in Ward County; the Means well, in Loving County; the McDowell No. 4 well, in Glasscock County; and the St. Rita well, in Reagan County. The most detailed record is afforded by the Means well, in which samples were taken every 5 feet, but all four show the occurrence of potash at more than one depth, and the Means record suggests that there may be eight or ten separate potash-bearing beds in some parts of the field. The different depths at which potash has been found in these wells suggest that it may occur in beds of local rather than of regional extent.

The principal results from the examination of drill records and drill cuttings were tabulated in Mineral Resources for 1921. The few additional data since gathered have already been distributed in press notices.

Interpretation of results.—The unsatisfactory nature of samples taken with churn drill or rotary outfits, such as were used in these wells, especially when the interval between samples is greater than 5 feet, is readily apparent. The mixture of the material effectually prevents recognition of individual beds, unless the beds are very thick. The danger of salting lower beds by material from higher levels and of misinterpretation by " hang-over " bailings is ever present. The necessary water in the hole, by its solvent effect on salts of differing solubilities, may cause either enrichment or impoverishment of the sample, and this effect may be intensified or diminished by the length of time the water is in contact with the sample. The results thus far gained are therefore to be regarded as suggestive rather than as giving any accurate idea of the number, character, and quality of the individual beds.

Need for further exploration.—Core drilling is needed to give accurate information. Drillers are urged to consider potash as well as oil in sinking new holes and to provide for coring the salt beds. Two attempts of this sort already made have been abandoned, at least temporarily, before the salt beds were reached. These failures were due in part to the lack of recognition by the drillers of the necessity of keeping the well properly cased.

A drilling solution other than water will be needed for the coring of the salts, otherwise the core may be damaged or lost. The Germans have used a 30 to 35 per cent solution of magnesium chloride for this purpose with apparently satisfactory results. Magnesium chloride, however, will prove expensive in western Texas, and it is probable that a saturated brine such as may be obtained from some of the lakes in the region may serve equally well.

The negative result at the Geological Survey's boring at Cliffside, which was thought to be favorably located, shows that barren areas may be interspersed with possibly productive areas. The only way in which the productive areas can be delimited is by drilling, and it may be necessary to drill many holes before the essential facts can be gathered. Gale[4] notes that when systematic exploration for

[4] Gale, H. S., The potash deposits of Alsace: U. S. Geol. Survey Bull. 715, pp. 17–55, 1920.

potash began in Alsace more than 100 deep borings were put down, 95 of which penetrated rock salt. Of these only 17 found potash layers. If this experience is any criterion for Texas it will be a long time before much will be known of the commercial value of the potash beds there from wildcat operations. Some far-sighted company with a view to future rather than immediate returns, or even the Government itself, should undertake a systematic campaign of investigation. It is believed that the evidence already obtained points strongly to the probability of deposits of commercial value and would justify the needed expenditure.

Outlook for commercial exploitation.—No one should enter the Texas potash field with the idea of obtaining quick and large returns. To the cost of preliminary exploration must be added the cost of sinking shafts to depths perhaps as great as 2,000 feet and the cost of construction and labor for operating deep mines. The present market for potash is largely in the eastern and southeastern seaboard States, which are accessible to cheaply transported foreign potash, whereas transportation charges from Texas to these States are higher. On the other hand, there is a growing need for fertilizers in the Central and Great Plains States, which are less accessible to foreign potash. These areas would be more easily reached by the Texas product. Sooner or later the demand in these States will be sufficient to support a potash industry, and Texas potash will come into its own. It is greatly to be hoped that this day will be speeded, for the economics of the hour demand a rehabilitation of our soils, which are rapidly being depleted, and an earnest effort to increase the amount of foodstuffs for export.

POTASH IN LAKES OF WESTERN TEXAS.

Although beds of natural potash salts, such as those believed to underlie the portions of western Texas above described, would probably assume high rank as sources of potash, it is interesting to note that western Texas has other sources of potash that might be utilized.

The Bureau of Economic Geology and Technology of the University of Texas has recently completed a detailed investigation of the brines of Double Lakes and Tahoka Lake, in Lynn County.[5] C. A. Maxwell, who put down test wells in these lakes, concludes that at Double Lakes there is enough brine of suitable quality to support a plant producing 650 tons of solids a day. The brine averaged 18° to 20° Baumé in gravity and had a potassium content of approximately 1.5 per cent, the remaining solids being salts such as sodium chloride (common salt), magnesium chloride, and sodium sulphate. The common salt or the magnesium chloride would be the principal product and the potash a by-product. Estimates of the cost of constructing and operating a plant capable of handling 1,000 tons of brine a day are given.

[5] Meigs, C. C., Bassett, H. P., and Slaughter, G. B., Texas alkali lakes: Texas Univ. Bull. 2234, 59 pp., 9 pls., 9 figs., Sept. 8, 1922.

NOTES ON FOREIGN POTASH.

GERMANY.

The following notes are abstracted from a report by William T. Daugherty, assistant trade commissioner at Berlin, dated December 21, 1922.

The pre-war monopoly enjoyed by Germany, though broken by the loss of the potash mines in Alsace-Lorraine, is not so seriously threatened as first signs after the war would have seemed to indicate. Energetic plans are in progress to penetrate America and recover Germany's most important pre-war market.

Production centers in Germany are roughly five—the Hannover, South Harz, Werra (Thuringia), Stassfurt, and Halle-Mansfeld-Unstrut districts, named in the order of their production in terms of K_2O in the first six months of 1922. In October, 1922, 128 shafts were being actively worked in all Germany and 83 were idle.

Potash produced in Germany, 1920–1922, by districts, in metric tons.

District.	Raw salts.			Pure potash content.		
	1920	1921	1922[a]	1920	1921	1922[b]
Hannover	3,508,544	2,912,997	3,812,220	407,822	334,426	446,620
Stassfurt	2,242,192	1,989,829	2,038,560	225,454	215,494	215,620
South Harz	2,005,122	1,746,431	2,283,520	269,060	231,720	299,080
Werra	2,037,862	1,457,128	2,373,960	233,128	170,819	273,160
Halle-Mansfeld-Unstrut	1,562,385	1,134,794	1,279,160	161,465	114,390	131,080
	11,356,105	9,241,179	11,787,420	1,296,929	1,066,849	1,365,560

[a] Approximate estimate on the basis of twice the production in the first six months of 1922.
[b] See footnote [a]. Figures for total production can probably be discounted about 25,000 tons.

The total production of raw salts in 1913 was 11,604,511 tons.

The maximum depth at which potash is profitably mined in Germany is now about 1,200 meters (3,900 feet). About 86 per cent of the potash lies within a depth of 1,200 meters, and 10 per cent lies at 1,200 to 1,500 meters (3,900 to 4,900 feet). Operations at greater depths are embarrassed by high temperature in the heavily moisture-laden mine air, as miners can not work easily in temperatures exceeding 28° C. (82° F.).

Approximately 76 chemical works out of 80 are now in operation in Germany for the purpose of refining the crude salts and separating their constituents into products best suited for fertilizers and other uses. The important feature of refining is the reduction in weight of the crude salts by rejecting useless constituents to obtain the potash in small bulk. This end is more sought at present on account of high freight rates, which preclude much more than before the war the purchase of raw salts by consumers at a distance from the potash districts.

A valuable by-product of the potash industry is rock salt, which has been sold in greater quantity since the war than ever before (1913, 400,000 tons; 1919, 600,000 tons; 1920, 1,250,000 tons). The best rock salt is produced in the Hannover district, where the rock salt contains about 99 per cent of sodium chloride.

The total sales of German potash salts in 1922 to domestic and foreign purchasers in terms of K_2O amounted to 1,330,000 metric tons. These are record figures, the sales for 1913 being 1,110,370 tons.

Approximately 25,000 miners and their helpers are employed underground at the present time, and 30,000 more are occupied in the chemical works and in the administrative branch of the industry above ground. Two underground crews each work a shift of $7\frac{1}{2}$ hours a day.

The potash districts, except the Halle district, are in agricultural communities, isolated from centers of population. It is usual for the potash miner to own a small plot of land, which he is able to farm when he is not at work in the mines. The potash industry is therefore marked by less labor discontent than perhaps any other industry in Germany.

Since the revolution of 1918 the German potash industry has been under the control of the Federal potash council (Reichskalirat), which is composed of 30 members and includes representatives of potash producers, dealers, and wholesale consumers. In addition, three members of the potash syndicate are admitted, as well as one expert in potash mining. Employers and laborers are represented in equal number in the council. The council supervises the industry, fixes prices, and issues regulations applying to the industry. It has the right to forbid the sinking of shafts and to close potash works.

The 13 shafts released to France with the return of Alsace-Lorraine have been rapidly improved and have entered into competition with German plants. French competition, however, is handicapped by having fewer plants and a smaller variety of natural salts. The occurrence of clay in the Alsatian deposits is said to be a disadvantage in the concentration of the raw salts. Freight rates constitute another handicap, the distance from Alsace to the nearest harbors, Antwerp and Rotterdam, being greater than that from the German mines to Bremen and Hamburg.

The German industry is apparently not greatly concerned over the French competition. It is roughly estimated by German authorities that France supplies not more than 20 per cent of all the potash sold to the United States, and they believe that this competition will diminish on account of the inability of the French to compete with German prices. Negotiations between Alsatian and German producers have been attempted with a view to agreeing upon a uniform price policy, but without success.

The Potash Importing Corporation of America, which took over the sale and distribution of German potash on May 1, 1923, has announced a new and lower price schedule, covering shipments from May to September.[6] The new prices are fixed on a basis of $34.55 a ton of 2,000 pounds net weight for muriate, 80–85 per cent; $43.67 for sulphate, 90–95 per cent; $25.72 for double manure salt, 48–53 per cent; $16.03 for manure salt, minimum 30 per cent; $10.55 for manure salt, minimum 20 per cent; $7.22 for kainite, 12.4 per cent. These prices are c. i. f. Atlantic and Gulf ports. The prices are subject to discounts of 1 per cent on purchases of 1,000 tons, 3 per cent on 3,000 tons, 4 per cent on 10,000 tons, 6 per cent on 15,000 tons, and 10 per cent on 20,000 tons.

[6] Chem. and Met. Engineering, May 14, 1923.

ALSACE.

John E. Teeple,[7] an American industrial chemist of note, gives an interesting account of a recent visit to the French potash mines made at the invitation of the director of the Société commerciale des potasses d'Alsace. The entire workings and records were opened to his inspection. He says:

> The writer left Alsace with the picture of a potash industry well managed by competent business and technical men, whose equipment for production has been very rapidly and thoroughly improved and whose improvement is still continuing; an industry which produced 228,000 tons of K_2O in 1922, which is producing at the annual rate of over 300,000 tons now, and which at any time on two months' notice could be producing at the rate of 500,000 tons K_2O per year, provided they have a market for so much; an industry which must hereafter always be reckoned with as an important factor in the world's potash production. * * *
>
> There is a sufficient quantity of potash to last several hundred years at the present rate of consumption at a depth of only about 700 meters (2,297 feet). The beds are thick enough to be mined economically; there is no trouble from accumulating water in the mines; and the product is richer than the German product—averaging 16 per cent or more of K_2O, while the German average is only about 12 per cent. There are 17 shafts at present in these potash beds. With the existing carriages and hoisting machinery their capacity is limited to from 700 to 1,200 tons of salt per day at the different shafts, with an average of close to 1,000 tons per day capacity per shaft. It will be seen that for the 17 shafts this represents a possible shaft capacity of over 2,500 tons of K_2O per day. As the shaft capacity is the limiting factor—the neck of the bottle—an estimate of a possible 500,000 tons per year is very conservative. * * *
>
> It is difficult to-day to compare costs of German, French, and American potash on account of the fluctuations in exchange. With German potash this is particularly true. During all the period that the mark has been falling there is no doubt that Germany could undersell any other country and still make a profit, but in looking ahead we must assume that conditions will some day stabilize. When this happens, as it must, then the play of real competitive forces will come into effect. To-day these competitive forces are overshadowed by exchange fluctuations, but in the long run the determining factors of competition will be, for example, the number of man-shifts of labor, the kilowatt-hours of electricity, the tons of coal, and the ton-miles of haul by rail or steamer that will be necessary in the French mines, the German mines, and the American potash works to produce 1,000 tons of K_2O and get it to a definite market. Figured on this basis, which is the one that is bound to prevail in the long run, it becomes obvious that France can very definitely compete with Germany. As a matter of fact, it costs no more in man-shifts and kilowatt-hours to get a ton of potash salts above ground in France than it does in Germany, and when this ton is above ground it contains more K_2O on the average in France than it does in Germany. This, in the long run, gives France the advantage, which is only partially offset by her longer haul to the sea. Buyers of potash should definitely convince themselves that both French and American production of potash is here and here permanently; that there is no longer a German monopoly.

OTHER COUNTRIES.

Spain.—A succinct general account of the potash deposits in Spain has been given by Gale.[8] Since the publication of his report conflicting statements regarding these deposits have been issued. For example, it is stated[9] that the American syndicate which acquired the Solvay concessions in Spain has terminated the contract and aban-

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[7] Ind. and Eng. Chemistry, April, 1923.

[8] Gale, H. S., Potash deposits in Spain: U. S. Geol. Survey, Bull. 715, pp. 1–16, 1921 (published separately June 5, 1920).

[9] Jour. Ind. and Eng. Chemistry, vol. 13, No. 11, p. 1084, 1921.

doned further operations, and also that the trial boring put down by the Spanish Government in association with the German potash syndicate is to be abandoned, having reached a depth of 1,200 meters without encountering either potash or rock salt.

On the other hand, it is said [10] that preparations are under way for the exploitation on a large scale of the potash deposits near Suria, in the Province of Lerida. A Belgian concern is now building an immense plant at Suria, which it is said will have a capacity more than equal to the total Spanish consumption. To facilitate the transportation of the potash a railroad to Manresa has been constructed, and plans have been completed to extend this line to the port of Barcelona. The product of the Minas de potasa de Suria is already being placed on the market, and it is thought that Spain will soon cease to import fertilizers of any kind if production in Lerida is increased as expected.

In an address at Madrid by Don Agustín Marín,[11] who, with D. César Rubio, has been engaged in the study of the Spanish potash deposits, he states that the anticline at Suria has been most investigated. Here the Solvay Co. has made 13 deep borings, and the ground cut in them differs much from boring to boring, the usual succession of the strata being marl and red sand, marl with gypsum, saline marl, etc. The depth of potassic salt ranges from 200 to 800 meters. There appears to be 10,000,000 tons of K_2O in the Suria anticline. This richness appears to be exceptional, because borings by a company that had concessions 5 miles west of Suria gave negative results, as did also borings at Boxadors, in the Suria anticline, and one at Sanabuja, in the Llobregos anticline. Some pits in the Cardona anticline made by the Sociedad de industria y comercio, at depths no greater than 100 meters, show no signs of industrial value.

A boring at Castellfullit, in the Suria anticline, passed through a number of saline beds with potash and stopped at a depth of 894 meters, after passing through the potash zone. Analysis in the Geological Institute gave for the sylvinite 65 per cent of potassic chloride and 32 per cent of sodic chloride, and for the carnallite 18.85 per cent of potassic chloride. The boring cut a fold at 500 and 800 meters, and both levels are exploitable; the thickness of the potassic zone is about 50 meters.

Marín thinks, from two borings by the State, that the potash bed is continuous and of great thickness, and, from the extent of the area tested, that "these beds, like those of Germany and Alsace, are indefinitely great."

Further exploration will be necessary before any satisfactory estimates of the extent of the Spanish field and of the quantity of potash in it may be made. Meanwhile it is interesting to note that production has begun.

Sweden.—A new form of potash fertilizer has been introduced in Sweden under the name "Electrokali." [12] This material is said to comprise finely ground clay from the electric-furnace manufacture of ferrosilicon from feldspar and iron trimmings.

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[10] Commerce Repts., March 20, 1922, p. 723.
[11] Am. Fertilizer, Mar. 11, 1922.
[12] Rock Products, Nov. 18, 1922, p. 48.

Norway.—Potash is recovered at the Dalen Portland cement mill, Brevik, Norway, by a modification of the Cottrell process, first installed by the Riverside Portland Cement Co., Riverside, Calif.[13] To increase the quantity of the by-product, feldspar is used instead of clay, so that the collected dust contains from 14 to 17 per cent of potash, whereas under ordinary conditions only 4 to 6 per cent is obtained. H. Holter, the general manager of this mill, makes a detailed report of his efforts to increase the by-product and estimates the future production of potash (K_2O) at 1 to 1.5 kilograms per sack of cement, in sufficiently rich mixtures to warrant shipment for use as fertilizers.

RECENT PATENTS.

The following United States patents covering the extraction of potash from silicate rocks have been issued recently:

1410642, Mar. 28, 1922, Bossett, H. P. Feldspar or any other silicate of alum and potash compound is ground to 100 mesh and heated with excess sodium carbonate and enough sodium sulphate to take care of the potassium. Soluble potassium sulphate and sodium silicate are leached from the insoluble sodium-aluminum silicate. Sodium silicate is removed from solution with lime, and the potassium salt is separated by evaporation.

1413045, Apr. 18, 1922, MacCarthy, F. B. Alunite is heated to a temperature of about 260° with exclusion of air in order to prepare it for leaching to obtain soluble potassium and aluminum sulphates.

1415346, May 9, 1922, Hayward, C. R., and Schleicher, H. M. Potassium-bearing slate is heated with H_2SO_4, soluble sulphates are leached out, and potash alum is crystallized.

1417919, May 30, 1922, Jackson, D. D. Natural potassiferous materials such as glauconite are heated with lime and NaCl or $CaCl_2$ at a temperature (preferably about 1150°–1190°) which is below the clinkering temperature but high enough to effect rapid formation and volatilization of KCl.

1418356, June 6, 1922. Blanc, Dr., and Gourdan, N. Felix. Leucite rock is ground to an impalpable powder and treated with carbonic acid (CO_2). The potassium carbonate thus formed can be readily washed from the insoluble material, or the leucitic rock can even be used as a fertilizer ingredient directly without lixiviation. In order to accomplish more easily the breaking up of the leucite the rock is first calcined in the presence of sodium or with quicklime, magnesia, etc. The calcined material is then introduced after grinding into the treating apparatus.

1422848, July 18, 1922, Glaeser, W. Alunite is heated to 700°–800° with sodium and $CaCl_2$ to produce HCl, and KCl is leached from the residue.

1430877, Oct. 3, 1922, Bailey, G. E., and Sedgwick, A. E. Lithium and potassium are extracted from their ores by mixing the ore with potassium sulphate and heating the mixture not over 1,500° F.

1433290, Oct. 24, 1922, Meadows, T. C., Hauber, M., jr., and Charlton, H. W. Greensand is digested at a temperature of about 245° under steam pressure for 40 minutes with CaO, NaOH, and $NaNO_3$ to form KNO_3. NaBr, $NaNO_3$, Na_2SO_4, $NaClO_3$, or other sodium salts may also be used to effect production of the corresponding potassium salts instead of KNO_3.

1452185, Apr. 17, 1923, Charlton, H. W., and Shreve, R. N. Greensand is heated to a temperature of about 240° with lime, H_2O, and $NaNO_3$ to form KNO_3 and NaOH. Patent No. 1452186 specifies heating the greensand under pressure with KNO_3 and milk of lime. The KNO_3 serves as an accelerating agent to promote the reaction.

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[13] Rock Products, Mar. 24, 1923, p. 21.

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PHOSPHATE ROCK.

By George Rogers Mansfield.[1]

PRODUCTION.

PHOSPHATE ROCK SOLD.

The sales of phosphate rock in the United States in 1922, compared with sales in 1921, increased 17 per cent in quantity but decreased 15 per cent in value. Except for those in 1919 and 1921 the sales in 1922 were lower than those of any preceding year since 1916, and the value of the rock sold was lower than in any other year since 1918.

Phosphate rock sold in the United States, 1917–1922.

Year.	Long tons.	Value.	Year.	Long tons.	Value.
1917	2,584,287	$7,771,084	1920	4,103,982	$25,079,572
1918	2,490,760	8,214,463	1921	2,064,025	12,270,070
1919	2,271,983	11,591,268	1922	2,417,883	10,482,846

In this report the value of domestic material means the selling value f. o. b. mines, so far as that can be determined from the returns submitted by the respective companies. Some of the companies, however, ship their rock to drying plants before selling, and others sell the rock f. o. b. foreign ports. Thus the figures given probably include an undetermined charge for transportation and are therefore somewhat higher than the actual values at the mine.

The sales of raw phosphate for direct application to the soil reached a maximum in 1919, as shown below. Although there was a noteworthy reduction in this business the following year the real break came in 1921, followed by a partial recovery (19 per cent) in 1922.

Raw phosphate rock sold for direct application to the soil, 1917–1922, in long tons.

1917	75,861	1920	72,801
1918	45,294	1921	13,503
1919	79,189	1922	16,029

Some demand for phosphate rock has been developed in recent years by furnaces to produce ferrophosphorus. This material is used by foundries and basic open-hearth furnaces to control the

[1] The statistical data in this chapter, except those showing imports and exports, were prepared by Miss Katrine W. Cottrell, of the United States Geological Survey, and the tables of imports and exports were compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, also of the Geological Survey.

phosphorus content of their steel products. In 1922 the quantity of phosphate rock thus sold by seven Tennessee producers amounted to 34,481 long tons.

A brief account of the manufacture and uses of phosphorus was given in the chapter on phosphate in Mineral Resources for 1917. A charge of phosphate rock, coke, and sand, heated in an electric furnace, yields about 86 per cent of crude phosphorus, which may be subsequently purified. In 1922 the quantity of phosphate rock sold by eight Tennessee producers for the manufacture of phosphorus amounted to 116,386 long tons.

PHOSPHATE ROCK MINED.

The quantity of rock mined in any year is not the same as the quantity sold, for the stock at the mines at the end of each year is variable. The quantity of rock mined in 1922 was less than that mined in 1921 by 89,318 tons. As shown in the following table, the decrease in the amount of rock mined was general throughout the eastern producing fields. The increase in the western field was due to the activity of the Anaconda Copper Mining Co. at Conda, near Soda Springs, Idaho, in mining rock to be shipped to its fertilizer factory at Anaconda.

Phosphate rock mined in 1921 and 1922, by States, in long tons.

State.	1921	1922	Per centage of increase or decrease.
Florida	2,088,251	2,018,809	−3
Tennessee and Kentucky	332,962	300,566	−10
Western States	4,961	17,481	+252
	2,426,174	2,336,856	−4

STOCKS.

At the end of 1922 the stocks on hand, as indicated by the figures for phosphate rock mined and sold, amounted to about 840,000 tons, which was less by 81,000 tons than the corresponding figure for 1921. The stocks reported separately by the producers for 1922 amounted to only 772,000 tons, a discrepancy of 68,000 tons, as yet unexplained.

PRODUCTION, BY STATES.

OUTPUT AND PRICE.

In 1922 there was an increase in the quantity of phosphate rock sold in Florida and Tennessee, a decrease in the Western States, and a net increase for the country of 17 per cent. The value of the product for the country, however, decreased 15 per cent. Although the price per ton of Florida soft rock and of rock from the Western States was greater in 1922 than in 1921, the average price for the country declined from $5.94 to $4.34, or 27 per cent.

Phosphate rock sold in the United States, 1921–22, by States.

State.	1921		1922	
	Long tons.	Value.	Long tons.	Value.
Florida:				
Hard rock	175,774	$1,806,671	188,084	$1,308,201
Soft rock	4,419	20,153	446	3,500
Land pebble	1,599,835	8,604,818	1,870,063	7,035,821
	1,780,028	10,431,642	2,058,593	8,347,522
South Carolina:				
Land rock	.....	.....	1,500	8,250
Tennessee:				
Brown rock	[a] 252,543	1,666,358	[a] 344,231	2,055,579
Blue rock	25,163	146,198	9,078	51,803
	[a] 277,706	1,812,556	[a] 353,309	2,107,382
Western States [b]	6,291	25,872	4,481	19,692
	2,064,025	12,270,070	2,417,883	10,482,846

[a] Includes brown rock from Kentucky. [b] 1921: Idaho and Montana; 1922: Idaho.

FLORIDA.

In 1922 Florida, the leading State in the production of phosphate rock, sold 85 per cent of all the phosphate rock sold in the United States. The quantity sold increased 16 per cent over the quantity in 1921, but the value decreased 20 per cent.

In the hard-rock field, which is concerned mainly with export trade, there was little activity in 1922, though the sales, largely from stocks, increased 7 per cent over those for 1921. The value, however, decreased 28 per cent.

Although the quantity of soft rock sold in 1922 was much less than in 1921, the average price per ton showed a gain of 72 per cent.

Land-pebble rock constituted 91 per cent of the entire Florida production. Conditions in the land-pebble field were much better than in the hard-rock field but were still far below normal. The sales of pebble rock in 1922 showed an increase of 17 per cent in quantity over those in 1921.

Florida phosphate rock sold in 1916–1922.

Year.	Hard rock.			Soft rock.		
	Long tons.	Value at mines.		Long tons.	Value at mines.	
		Total.	Average.		Total.	Average.
1916	[a] 47,087	[a] $295,755	$5.26	(a)	(a)	$9.76
1917	[a] 18,608	[a] 159,366	5.93	(a)	(a)	12.40
1918	62,052	377,075	6.08	8,331	$147,103	17.66
1919	285,467	2,452,563	8.59	14,498	196,318	13.54
1920	400,249	4,525,191	11.31	13,953	190,551	13.66
1921	175,774	1,806,671	10.28	4,419	20,153	4.56
1922	188,084	1,308,201	6.96	446	3,500	7.85

[a] Soft rock included with hard rock.

Florida phosphate rock sold in 1916–1922—Continued.

Year.	Land pebble.			Total.		
	Long tons.	Value at mines.		Long tons.	Value at mines.	
		Total.	Average.		Total.	Average.
1916	1,468,758	$3,874,410	$2.64	1,515,845	$4,170,165	$2.75
1917	2,003,991	5,305,127	2.65	2,022,599	5,464,493	2.70
1918	1,996,847	5,565,928	2.79	2,067,230	6,090,106	2.95
1919	1,360,235	5,149,048	3.79	1,660,200	7,797,929	4.70
1920	2,955,182	14,748,620	4.99	3,369,384	19,464,362	5.78
1921	1,599,835	8,604,818	5.38	1,780,028	10,431,642	5.86
1922	1,870,063	7,035,821	3.76	2,058,593	8,347,522	4.05

SOUTH CAROLINA.

No rock was mined in South Carolina in 1922, but some land rock was sold from stock left from previous years.

South Carolina phosphate rock sold in 1918–1922.

Year.	Long tons.	Value at mines.	
		Total.	Average
1918	37,040	$164,650	$4.45
1919	60,823	308,968	5.08
1920	44,141	367,209	8.32
1921			
1922	1,500	8,250	5.50

TENNESSEE AND KENTUCKY.

The phosphate rock sold in Tennessee and Kentucky in 1922 increased 27 per cent in quantity and 16 per cent in value, though there was a decrease of 9 per cent in the average price per ton. Most of the product was brown rock mined in Tennessee. The figures for Kentucky may not be shown separately because there was but one operator. The blue rock decreased 64 per cent in quantity and 65 per cent in value.

Tennessee phosphate rock sold in 1916–1922.[a]

Year.	Brown rock.[a]			Blue rock.			Total.[a]		
	Long tons.	Value at mines.		Long tons.	Value at mines.		Long tons.	Value at mines.	
		Total.	Average.		Total.	Average.		Total.	Average.
1916	364,108	$1,357,888	$3.73	47,682	$152,465	$3.20	411,790	$1,510,353	$3.67
1917	447,203	1,920,533	4.29	65,904	205,820	3.12	513,107	2,126,353	4.14
1918	[b]374,535	[b]1,917,546	5.12	(b)	(b)	(b)	374,535	1,917,546	5.12
1919	475,475	3,123,565	6.57	58,550	290,951	4.97	534,025	3,414,516	6.39
1920	556,177	4,425,761	7.96	78,671	518,234	6.59	634,848	4,943,995	7.79
1921	252,543	1,666,358	6.60	25,163	146,198	5.81	277,706	1,812,556	6.53
1922	344,231	2,055,579	5.97	9,078	51,803	5.71	353,309	2,107,382	5.96

[a] Small quantity of brown rock from Kentucky included with Tennessee.
[b] Blue rock is included with brown rock.

WESTERN STATES.

The banner year in phosphate production in the western field was 1920. In 1921 there was a sharp decrease, and in 1922 there was a further decline of 29 per cent in quantity and 24 per cent in value. Only three producers were active, all in the Idaho field.

Western States phosphate rock sold in 1916–1922.

Year.	Long tons.	Value at mines.	
		Total.	Average.
1916	1,703	$5,350	$3.14
1917	15,096	41,756	2.77
1918	11,955	42,161	3.53
1919	16,935	69,855	4.12
1920	55,609	304,006	5.47
1921	6,291	25,872	4.11
1922	4,481	19,692	4.39

DISTRIBUTION AND CHARACTER OF DEPOSITS.

Brief accounts of the distribution and character of phosphate deposits, both in the United States and in foreign countries, have been given in Mineral Resources for previous years, especially in the volumes for 1918 and 1919. Additional accounts of the domestic occurrences are cited in the bibliography at the end of this chapter.

COMPARISON OF PHOSPHATE ROCK FROM DIFFERENT FIELDS.

The Florida phosphate is distinguished from that of the other fields in the United States by its generally lighter color and by the finer texture, the more nearly structureless character of individual masses, and the more common association of bones, teeth, and fragments of replaced shell with the rock. The hard rock is largely a residual accumulation upon an irregular limestone floor, of Eocene age, of phosphatic débris gathered by the agencies of solution, secondary deposition, and slumping from phosphatic strata of Miocene age. The direction of concentration has been mainly downward, with little lateral transportation of the phosphate-bearing materials or solutions. The same causes have accentuated the irregularities of the floor on which the phosphate has accumulated. The result is extreme irregularity in thickness and quality of the phosphate-bearing mass or matrix. Only intensive prospecting by drilling can determine the extent, thickness, and quality of the phosphate in any tract of supposedly phosphate-bearing land.

The land pebble is a concentration of phosphate rock by the same processes and from the same sources as the hard rock, with the added features of erosion and redeposition. That is to say, portions of the Miocene phosphate-bearing strata and accumulations of hard rock have both been eroded and redeposited as part of a new group of marine beds of Pliocene age. The floor on which this deposit is laid down is more even and smooth than the floor of the hard-rock deposits. The formation itself is also more evenly distributed through the region in which it occurs. Thus prospecting to determine the charac-

ter of any particular tract need not be so intensive or expensive as in the hard-rock field. Nevertheless, the distribution of the phosphatic matrix within the formation is decidedly uneven, both as regards thickness and quality, so that careful prospecting must precede commercial development.

In both the hard-rock and pebble fields considerable overburden must be removed, and the matrix includes much clay and sand, together with boulders of limestone and chert, so that thorough washing is necessary to separate the phosphate from its unprofitable matrix. Some soft phosphate is lost by this process, but the washings from the rock as mined are accumulated in worked-out pits, so that some of this material may be recovered later should the market justify the procedure.

The Tennessee brown phosphate is also a residual deposit but generally is of more granular appearance than the Florida rock, and its color is darker, being dark brown or black to yellow. It also has accumulated upon a limestone floor whose inequalities have been accentuated by solution. The several phosphatic formations that have contributed to it are much older than the Florida rocks, being of Ordovician age.

The Tennessee blue phosphate is an original marine deposit, corresponding in a way with the land-pebble deposit of Florida. It consists of earlier residual brown phosphate, rearranged and redeposited by the sea, together with some additional phosphatic material that was present in the Devonian or Mississippian waters in which it was laid down. Its texture is finely granular or even oolitic in appearance, and its color is black to dark blue, weathering brown.

The Tennessee brown phosphate must be prospected, mined, and washed in much the same manner as the Florida rock. The blue rock, on the other hand, is mined by underground methods like coal. Unfortunately the bed is thin, rarely more than 3 feet thick and usually less, and much barren material must be moved in order to get the desired phosphate.

The western phosphate rock is much like the Tennessee blue rock in appearance, having a characteristic oolitic texture and a black to brown or grayish color. It is more or less friable, though some beds are hard and dense. It is an original marine deposit, there having been, so far as known, no previous accumulation of residual phosphate, such as was available for rearrangement and redeposition when the Tennessee blue phosphate and the Florida land pebble were laid down. It must be mined like coal, by underground methods, but the productive beds are so thick, usually 5 feet or more, that much of the development work in a given bed can be carried on in the phosphate rock itself. Thus little waste material need be handled. Moreover, the western rock, like the Tennessee blue rock, needs no washing. The rock thus far mined is relatively dry, but some of the producers run it through a dryer before shipping in order to command a higher price.

UNITED STATES PHOSPHATE RESERVES.

The Government now has two extensive phosphate reserves, one in Florida and the other in the Western States.

FLORIDA.

The first withdrawal of public phosphate land in Florida, which included 2,400 acres, was made on July 2, 1910. Further withdrawals were made in succeeding years until a total of 122,816 acres had been reserved. Restorations to entry since made amount to 3,293 acres, so that on December 31, 1922, the net total outstanding withdrawals were 119,523 acres. This land is in small parcels, ranging from less than 40 to 160 acres, in 295 townships and 31 counties. It is distributed in a broad belt that extends from Apalachicola River at the northwest as far south as the mouth of Caloosahatchee River, near Fort Myers, and is from 10 to nearly 100 miles wide.

WESTERN STATES.

The western phosphate reserve was set up on December 9, 1908, when the Secretary of the Interior withdrew from all kinds of entry 4,541,300 acres of land in Idaho, Utah, and Wyoming. It has been considerably modified and reduced by subsequent orders based upon examinations by the Geological Survey in those fields, and a large area in Montana has been added to the reserve. The great bulk of the phosphate area in the States named is on public land, though some has passed into private ownership. The outstanding withdrawals on January 1, 1923, are indicated below:

	Acres.
Utah	302,465
Idaho	720,534
Wyoming	995,049
Montana	287,883
	2,305,931

Of this land areas amounting to 261,971 acres in Idaho and 2,000 acres in Wyoming have been examined in detail and formally classified as phosphate land. Similarly 5,751 acres in Idaho, including 4,060 acres in the Fort Hall Indian Reservation, and 23,293 acres in Wyoming, including 20,576 acres in the Wind River Indian Reservation, not embraced in outstanding phosphate withdrawals, have also been examined and classified as phosphate land. The total area of public land in the western field that may be regarded as containing workable phosphates therefore amounts to 2,334,975 acres. Not all this territory contains high-grade rock, but the estimates given below, which are conservative and incomplete, show that a vast tonnage of high-grade rock may be expected.

Under the act of July 17, 1914, agricultural entries may be made upon withdrawn phosphate lands, but the mineral rights are reserved to the United States.

REVISED ESTIMATES OF TONNAGE.

In connection with the revision and extension of phosphate classification in the western field the original tonnage estimates for Idaho, Montana, and Wyoming have been revised. These estimates relate chiefly to the main bed and thus exclude some workable high-grade rock and much lower-grade material that may eventually become workable. Numerous areas of considerable size that may contain phosphate deposits at workable depths are also excluded because the

phosphate rock is covered by later deposits that conceal the structure of the underlying beds, so that any estimate of the phosphate content would be unreliable. Large areas of the lands withdrawn have not yet been examined, and hence no estimate of tonnage is available for them. It is believed, therefore, that the estimates here given are low and that when the withdrawn lands have been fully explored the total may be considerably increased.

Estimate of phosphate rock in the United States available December 31, 1922, in long tons.[a]

Field.	Estimated quantity at end of 1915.	Approximate quantity mined 1916–1922.	Estimated quantity available.
Eastern field:			
Arkansas	20,000,000	.....	20,000,000
Florida	227,000,000	15,000,000	212,000,000
Kentucky	1,000,000	100,000	900,000
South Carolina	9,000,000	200,000	8,800,000
Tennessee	88,000,000	3,000,000	85,000,000
	345,000,000	18,300,000	326,700,000
Western field:			
Idaho	[b] 4,997,809,000	92,000	4,997,717,000
Montana	[b] 273,785,000	.....	273,785,000
Utah	96,750,000	5,000	96,745,000
Wyoming	[b] 115,754,000	9,000	115,745,000
	5,484,098,000	106,000	5,483,992,000
Grand total	5,829,098,000	18,406,000	5,810,692,000

[a] Mansfield, G. R., The phosphate resources of the United States: Second Pan-American Sci. Cong. Proc., vol. 8, pp. 729–766, 1917.
[b] Figures revised to agree with later plan of classification.

VANADIUM AND CHROMIUM IN WESTERN PHOSPHATE.

The green color of some of the solutions produced by treating western phosphate rock with sulphuric acid has been noticed by a number of observers. The suggestion was made informally to a member of the Geological Survey by Dr. F. K. Cameron that this color might be due to the presence of chromium. Typical samples of the western rock analyzed in the laboratory of the Geological Survey in accordance with this suggestion have yielded from 0.08 to 0.23 per cent of chromic oxide (Cr_2O_3). According to Clarke[2] the average proportion of chromic oxide found in 256 analyses of igneous rocks in the laboratory of the Geological Survey was 0.05 per cent. The percentages found in the western phosphate rock are therefore unusual and of scientific interest, though as yet they have no commercial significance.

Another cause for the green color was found to be the presence in the phosphate rock of small amounts of vanadium pentoxide (V_2O_5). The possibility of the occurrence of vanadium in phosphate rock was suggested informally to the writer some years ago by Dr. W. F. Hillebrand. Analyses of typical samples of the better grade of Idaho phosphate have shown quantities of V_2O_5 ranging from 0.11 to 0.52 per cent. In view of the small percentage of V_2O_5 in the commercial ores of vanadium now used, these quantities in the phosphate rock, though small, may acquire commercial significance, especially

[2] Clarke, F. W., The data of geochemistry, 4th ed.: U. S. Geol. Survey Bull. 695, pp. 702–703, 1920.

because some of the processes for the manufacture of superphosphates involve concentration of the phosphorus pentoxide and presumably also of the vanadium pentoxide. So far as known the problem of separating small quantities of vanadium from large quantities of phosphorus has not before been attacked. Concerning this phase of the matter Frank L. Hess says: "The fact that vanadium in ferrovanadium is now worth about $3 a pound and at its lowest has averaged at least $2 a pound allows a considerable amount of work and expense in its isolation and makes the problem of separation sound very engaging, and it does not seem impossible of solution."

PHOSPHATE LEASES.

Under the act of Congress that provides for the leasing and use of phosphate lands the Department of the Interior has drawn up certain regulations,[3] including a sample lease, which embody the provisions of the law. A copy of these regulations may be obtained by addressing the Commissioner of the United States General Land Office, Washington, D. C. The leasing law supersedes the older mineral location laws, so far as phosphate, coal, oil shale, gas, and sodium are concerned. A lease may embrace not more than 2,560 acres of land in compact form, in a tract whose length shall not exceed two and one-half times its width. The lands must be taken in units of legal subdivisions. Applicants for leases must be citizens of the United States, associations of citizens, or corporations organized under the laws of the United States or of any State or Territory thereof. There is a minimum requirement of bona fide expenditure for the development or improvement of each leased tract, and the lessee is required to furnish a bond conditioned upon the expenditure of the specified amount. There is also a provision for minimum production, with a royalty payable to the Government. An application for a lease must be made under oath and filed in the proper district land office, addressed to the Commissioner of the General Land Office.

No general regulations have been issued as to royalties to be required under the leasing law. Under the terms of that law the minimum stipulated royalty is 2 per cent of the gross value of the output at the mine. Under current procedure the General Land Office in submitting a request to the Geological Survey for an opinion about the suitability of a particular land area for a leasing unit requests also a recommendation regarding the amount of royalty to be charged. The Geological Survey has considered each case on its merits, taking into account the thickness and quality of the phosphate bed, its geologic structure, its relation to suitable means of transportation, and the character of existing improvements on the given tract or on neighboring tracts of land. In addition the Geological Survey has recognized that the western phosphate industry is in its infancy and that all possible aid should be rendered to those who seriously undertake to exploit the phosphate beds. It has therefore taken the position that at the outset, at least, the royalties should be low. Later, if conditions warrant, higher royalties may be charged, but such increase in royalties would not affect leases

[3] Dept. Interior, General Land Office, Cir. 696, 1920.

already granted until the expiration of the 20-year period allowed by law. The royalties thus far recommended have been 2, 2¼, and 2½ per cent, corresponding, respectively, to 8, 9, and 10 cents a ton upon an assumed gross value of $4 a ton for the output at the mine. These royalties are fairly comparable with that of 2 per cent on the value f. o. b. the nearest shipping point charged by the State of Idaho for certain State lands in Bear Lake County.

RECENT METHODS OF TREATMENT.

Anaconda treble superphosphate.—The only method that has thus far been developed on a commercial scale for producing a concentrated phosphatic fertilizer from western phosphate rock was put into operation in 1920 by the Anaconda Copper Mining Co. at Anaconda, Mont. The process has already been described in Mineral Resources for 1920. It consists essentially of the treatment of raw phosphate rock with equal weights of 60 per cent sulphuric acid to make phosphoric acid, which is mixed with pulverized raw phosphate rock in the proportion of 2 : 3. The finished product contains about 48 per cent available phosphoric acid and is called Anaconda treble superphosphate.

Kreiss process.—In October, 1922, the Non-Acid Fertilizer & Chemical Co., of Lakeland, Fla., licensees of the A. L. Kreiss process, began operating a plant near Lakeland, which gives promise of commercial success. Local phosphate rock containing about 60 per cent tricalcium phosphate is mixed with an alkali flux (potassium carbonate, imported from Germany) and heated in a rotary kiln to a temperature of about 2,000° F. A clinker resembling that of cement and said to contain 15 per cent of available phosphoric acid (including about 2 per cent of citrate-soluble phosphate) and 6 per cent of available potash is formed. This is ground and mixed in any desired proportion with other ingredients to make a complete fertilizer. The phosphate so treated contains no free acid and tends to reduce rather than to increase soil acidity. The plant at Lakeland is said to have a capacity of 80 to 100 tons a day and to have produced potassium phosphate at the rate of 40,000 tons annually. A random sample of the product collected by the writer in a recent visit to the plant was tested in the laboratory of the Geological Survey and found to substantiate in a general way the claims of the company regarding its phosphate and potash content. The sample was distinctly alkaline, although the degree of alkalinity was not determined.

Excess alkalinity may be expected to neutralize the soil acids and thereby lessen the amount of citrate-soluble phosphate that may really be made available. Many plants are highly sensitive to the condition of the soil and fare badly or prosper according to whether their requirements of soil acidity or alkalinity are met. Thus, according to E. T. Wherry, of the United States Bureau of Chemistry, citrous fruits are tolerant of slight alkalinity in the soil, but their leaves are likely to turn yellow if too much alkali is present. The condition of the soil is determined not only by its constituents but also by the local conditions of soil drainage, whether downward and outward, or the reverse.

It is clear that caution should be exercised in the use of an alkaline fertilizer and that local conditions will have much to do with the

question whether it may be used to advantage. According to A. G. Meminger, treasurer and general manager of the company, steps have been taken in mixing the prepared fertilizers to reduce the alkali content. He reports good business and generally satisfactory results from the use of this fertilizer.

Electric-furnace process.—The following account is abbreviated from a statement made by Theodore Swann, president of the Federal Phosphorus Co., Anniston, Ala.[4]

The Southern Manganese Corporation, a company allied with the Federal Phosphorus Co., built, in 1917, a 20,000-kilowatt plant at Anniston, with eight electric furnaces, for the production of ferromanganese and other alloys. When the war demand ceased and ferromanganese could be imported more cheaply, operation of the furnaces for ferromanganese was discontinued.

Experimental work was undertaken in the summer of 1918, at the suggestion of the War Industries Board, on the production of potash, of which the supply was very short; work was also started on a plant to produce elemental phosphorus for smoke-screen work in war activities. This experimental work was continued from the summer of 1918 until the summer of 1921, when it was put on a commercial basis.

The electric-furnace process was developed with the primary idea of producing high-grade phosphoric acid, low in impurities. The process consists of charging phosphate rock into an electric furnace with coke breeze to supply the carbon necessary as a reducing agent, and with silica rock to flux out the excess lime present in the phosphate rock. Iron trimmings were added to form ferrophosphorus, an alloy used in the steel industries. The production of ferrophosphorus serves to remove a large part of the iron from the phosphoric acid; this iron would be present and difficult to remove if the rock were treated with sulphuric acid, as in the old process. The phosphorus liberated by the action of the electric furnace, on coming into contact with air above the stock or charge in an inclosed furnace, burns to phosphorus pentoxide, a heavy white fume that is carried over with other gases. When it is cooled to certain temperatures it absorbs water and a portion condenses; the remainder is collected by electric precipitators. The product is recovered from the furnace gases as a liquid.

As collected the phosphoric acid contains about 65 per cent of P_2O_5 or 90 per cent of H_3PO_4. While the first development was made for the higher-grade acids, substantially all of the capacity is now being used for lower grades, which still have a high degree of purity and concentration. The work at Anniston during the last three years has definitely proved that with cheap power and proper location of a plant, concentrated mixed fertilizer can be produced at a price that will enable it to compete with fertilizer produced by the old method and generally be cheaper.

Phosphoric acid, as produced in the electric furnace, of a concentration of 65 per cent, could be used to fix ammonia from by-product gas or the ammonia gas from either the Haber or the cyanamid process and thus save the cost of sulphuric acid in fixing the ammonia gas into a salt.

[4] Manufacturers' Record, Apr. 13, 1922, pp. 51–52.

Potash can also be produced in the electric furnace, but the cost as compared with that of potash purchased abroad or in the United States has not been definitely established. To produce potash, it is necessary to add sufficient potash-bearing shale or feldspar to flux out the excess lime present in the phosphate rock; thus potassium phosphate can be collected in liquid form, and this could be used to fix ammonia gas, thus producing a complete concentrated fertilizer by the electric-furnace process.

The Federal Phosphorus Co. is now operating three furnaces, with a total of approximately 12,000 horsepower, for the production of ferrophosphorus and high-grade phosphoric acid for use in food products. It has made fertilizer material in small quantities, working out the process and demonstrating the power consumption. The developments at Anniston prove the feasibility of producing phosphoric acid for fertilizer by the electric furnace with cheap power. It is expected that plans will soon be made for the construction of a plant designed especially for the production of fertilizer materials.

Experiments by the Bureau of Soils.—For the last few years scientists of the United States Bureau of Soils have been experimenting with the production of phosphoric acid by volatilizing the acid and collecting the fumes by means of the Cottrell electric precipitator. By such methods it is not only possible to treat relatively low-grade material, but a product is obtained sufficiently concentrated to permit the expense of long freight hauls and heavy handling. From the account given by Waggaman and Turley[5] it appears that in spite of certain difficulties and limitations in the conditions of experimentation the results obtained are on the whole satisfactory, and it is believed that the investigation has been carried to the point where the commercial feasibility of the process has been demonstrated and its ultimate economic success practically assured.

The furnace used in these experiments is a combination of the open-hearth and blast-furnace types and is heated by two Lalor fuel-oil burners, one at each end of the elongated slag chamber. The charge chamber has a capacity of 700 pounds of briquets composed of ground phosphate rock, sand, and coke. (See U. S. Patent 1334474.) A steel tank holding 500 gallons of fuel oil is used as the main fuel reservoir, and the oil is fed by gravity to a pump, which forces it to the burners under a pressure of 50 to 800 pounds. The air for combustion of the fuel is preheated and is furnished by three Leiman positive-pressure blowers. The fumes and gases pass to a dust catcher and thence to three stoves used for burning the combustible gases. From the stoves the gases are led to the Cottrell electric precipitator, where the acid is collected. A monel-metal exhaust fan serves to withdraw the gases from the furnace and discharge them into the precipitator pipes.

In the last part of the final run made with this apparatus the authors cited were able to obtain a volatilization of 97 per cent of the phosphorus pentoxide (P_2O_5) present in the original charge. The yield of P_2O_5 amounted to 5.56 pounds to the gallon of fuel oil. Estimates of the cost of manufacture of P_2O_5 by the furnace method indicate a cost of $49.83 a ton, or 2.49 cents a pound, as compared with a selling price of 6.25 cents a pound. The cost of producing a

[5] Waggaman, W. H., and Turley, T. B., Investigations on pyrolitic production of phosphoric acid: Chem. and Met. Eng., vol. 23, No. 22, Dec. 1, 1920.

ton of P_2O_5 in the form of acid phosphate, as estimated from figures furnished by three large manufacturers, is $81.25 a ton, or 4.6 cents a pound.

W. H. Ross and A. L. Mehring, of the same bureau, are perfecting a process whereby low-grade phosphate and low-grade coal, with some sand or sandstone and shale, are treated in an electric furnace to produce red phosphorus. The process gives promise of cheap and effective commercial development, but the details are not yet available.

IMPORTS AND EXPORTS.

The fertilizer materials imported into the United States in 1922 comprised many compounds containing phosphorus, potash, and nitrogen. Those containing phosphorus included apatite, bone ash, guano, basic slag, and phosphate rock and are listed below.

Phosphatic fertilizers imported and entered for consumption in the United States, 1918–1922.

Fertilizer.	1918		1919		1920		1921		1922	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Apatite	1	$30	28	$825	142	$4,904	.....	.....	.....	.....
Bone dust or animal carbon, and bone ash, fit only for fertilizing	5,098	153,349	5,948	182,785	17,793	908,130	21,516	$799,591	32,274	$860,683
Guano	8,206	280,544	7,017	255,995	53,790	4,583,313	1,751	89,527	13,007	514,325
Phosphates, crude	.....	.....	34	457	63	2,090	3,535	43,960	5,890	95,846
Slag, basic, ground or unground	93	381	46	2,613	.....	.....	.....	.....	324	9,762

The quantity of phosphate rock exported from the United States has diminished from the relatively high figure of 1,069,712 long tons reached in 1920, when exports nearly gained their pre-war level (1,366,508 tons). The quantity exported in 1922 was little more than half the pre-war figure and represented a decrease of 2 per cent in quantity and 20 per cent in value as compared with 1921. The following table shows exports of phosphate rock in the last four years:

Phosphate rock exported from the United States, 1919–1922.

Kind.	1919		1920		1921		1922	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Phosphate rock, ground or unground, not acidulated:								
High-grade rock	215,039	$2,261,852	344,896	$4,496,457	182,594	$2,592,541	202,300	$2,548,587
Land pebble	128,860	904,308	693,355	5,593,814	544,425	4,627,875	512,777	3,269,179
All other	34,832	401,822	31,461	479,904	6,293	99,721	4,217	40,401
	378,731	3,567,982	1,069,712	10,570,175	733,312	7,320,137	719,294	5,858,167

The destination of these exports is given in the following table, which shows that in 1922 Germany was the principal importer of the high-grade rock, with Belgium second. Germany's importations have on the whole increased rather steadily since 1919. Germany and Belgium are also considerable users of land-pebble phosphate, but Spain was the principal importer of land pebble in 1922, followed by the Netherlands and Denmark. Japan, which in 1920 imported various grades of phosphate rock amounting in all to 48,190 long tons, imported in 1922 only 8,203 tons.

Phosphate rock, ground or unground, not acidulated, exported from the United States, 1919–1922.

High-grade rock.

Country.	1919		1920		1921		1922	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Belgium	16,161	$161,610	55,645	$690,705	41,513	$622,695	32,200	$483,000
Canada	752	14,195	2,226	39,442	6,559	89,262	3,892	47,045
Cuba	1,884	21,216						
Denmark	80,753	828,519	58,211	755,655			4,400	66,000
England			8,306	124,587	5,042	78,166		
Finland							5,650	74,759
Germany	28,062	300,782	104,433	1,407,445	91,880	1,293,893	113,118	1,335,372
Ireland			4,600	69,000				
Japan			4,292	35,076				
Netherlands	10,702	134,147	19,522	266,217	25,100	328,900	19,991	258,021
Norway	18,517	201,036	30,978	428,865	2,500	38,500	3,200	48,000
Poland and Danzig					10,000	141,125	16,349	183,890
Spain	18,527	200,255	24,480	312,845				
Sweden	37,106	375,048	32,203	366,620			3,500	52,500
Switzerland	2,575	25,044						
	215,039	2,261,852	344,896	4,496,457	182,594	2,592,541	202,300	2,548,587

Land pebble.

Belgium			26,788	$216,934	45,160	$389,695	53,793	$309,183
British South Africa							3,000	17,250
British West Indies			3,675	25,100				
Canada	1,202	$4,807	3,854	30,494	146	2,676	9,895	75,028
Cuba	8,449	32,857	34,208	262,204	7,055	43,101	9,017	26,073
Denmark	17,943	161,776	18,406	192,648	9,062	103,791	54,605	429,984
England	27,324	177,993	154,975	1,277,278	52,924	422,495	36,983	270,300
France					20,380	124,323	27,149	185,121
Germany			9,129	96,855	79,004	884,135	51,578	283,918
Honduras					3,596	16,182		
Ireland	11,517	75,889	61,097	395,797	36,713	289,779	18,716	141,504
Italy					7,352	73,520		
Japan			42,516	322,428	20,743	113,799	8,201	31,804
Netherlands	26,953	185,256	70,477	505,612	69,416	558,912	86,218	498,516
Norway			2,500	22,500				
Portugal			8,305	55,381	24,545	260,315		
Scotland	7,150	82,225	77,487	574,305	17,438	138,085	13,715	104,014
Spain	16,072	108,540	139,066	1,226,670	133,462	1,006,634	122,443	788,027
Sweden	12,250	74,965	40,872	389,608	17,429	200,433	17,464	108,457
	128,860	904,308	693,355	5,593,814	544,425	4,627,875	512,777	3,269,179

Phosphate rock, ground or unground, not acidulated, exported from the United States, 1919–1922—Continued.

All other phosphate rock.

Country.	1919		1920		1921		1922	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
Barbados	50	$1,375						
Belgium	5,554	55,540						
British Honduras	1	7						
Canada	5,303	70,958	12,955	$187,780	4,031	$72,023	4,196	$38,281
China	1	6						
Costa Rica	250	1,450						
Cuba	4,156	74,181	8,134	160,824	1,197	23,635		
Denmark	2,000	36,960						
England	1	2						
Germany			3,300	51,150				
Honduras	1	28			22	250		
Ireland			2,500	14,250			19	2,100
Jamaica	75	1,601						
Japan			1,382	12,737			2	20
Mexico	2	70			110	2,975		
Netherlands	3,500	59,500						
Newfoundland and Labrador			37	316	23	463		
Norway	2,200	17,607						
Oceania:								
Australia			3	30				
New Zealand			1	10				
Other British					1	17		
Other British West Indies	1	10	149	3,307	9	358		
Spain			3,000	49,500				
Sweden	11,737	82,527						
	34,832	401,822	31,461	479,904	6,293	99,721	4,217	40,401

The following table shows the relation between the total quantity of phosphate rock sold and the quantity exported during the last five years.

Phosphate rock sold in and exported from the United States, 1918–1922.

Year.	Sold (long tons).	Exported (long tons).	Proportion of exports to domestic sales (per cent).
1918	2,490,760	143,455	6
1919	2,271,983	378,731	17
1920	4,103,982	1,069,712	26
1921	2,064,025	733,312	36
1922	2,417,883	719,294	30

WORLD'S PRODUCTION AND CONDITIONS.

The United States has been the world's largest producer of phosphate rock, and available figures for 1922 indicate that its leadership continues. It is interesting, however, to note the close approach made by Tunis in 1921 and 1922. Algeria and Egypt also seem to be making generally steady gains, though their production in 1922 was considerably less than it was for 1920, which seems to have been a banner year for most producing countries. Algeria, Egypt, and Tunis together produced 2,320,824 metric tons in 1921 and 2,502,524 tons in 1922, exceeding the total production of the United States for those two years. With Morocco entering the list of producing countries

under conditions that admit of large-scale operations, it seems clear that leadership in the world's phosphate production has already passed from North America to North Africa.

During the war European countries learned to do without American phosphate rock, and since then exchange rates have been so unfavorable that they could not resume imports of American rock on anything like a pre-war basis. Despite the admittedly superior qualities of high-grade Florida and Tennessee phosphate, the present lack of demand for it in Europe bids fair to become permanent, especially if the Moroccan product proves to be of as high quality as reported. It seems doubtful, therefore, if United States producers can much extend their present export trade.

The alternative would seem to be the development of increased domestic consumption. Two elements need consideration—the continued education of American agriculturists to the advantages of a wider use of fertilizers and the reduction in the cost of the fertilizers. It would seem that the cost of handling and transporting prepared fertilizers could be considerably reduced by the manufacture and sale of much more concentrated types of fertilizer than those commonly sold. The problem of the marketing and use of concentrated fertilizers is not simple, but it is not impossible of solution.

World's production of phosphate rock, 1917–1922, in metric tons.

Country.	1917	1918	1919	1920	1921	1922
Algeria	[a] 234,825	[a] 198,539	271,162	502,614	398,800	484,304
Angaur Island	(b)	(b)	(b)	(b)	(b)	(b)
Belgium	138,300	61,700	90,970	133,040	55,040	56,840
British India [c]	.....	5,182	508	.....	353	(b)
Canada [c]	135	127	22	.....	27	82
Chile [c]	.....	.....	1,500	1,510	1,200	(b)
Christmas Island	91,332	54,227	69,722	70,691	(b)	(b)
Dutch West Indies:						
Aruba	3,639	.....	.....	.....	(b)	(b)
Curacao			10,058	61,440	60,872	(b)
Egypt	115,732	31,147	29,365	114,813	122,024	60,220
France	(b)	(b)	103,869	124,930	110,884	(b)
French Guiana	(b)	(b)	(b)	(b)	(b)	(b)
Germany (Bavaria)	.....	.....	701	4,934	(b)	(b)
Indo-China	(b)	(b)	7 050	13,200	9,900	(b)
Japan, including Rasa Island	121,628	192,271	122,868	97,340	32,001	(b)
Madagascar	.....	.....	.....	.....	.....	[a] 5,210
Makatea Island	32,250	40,000	40,000	32,000	60,000	(b)
Morocco (French)	(b)	(b)	(b)	(b)	[a] 6,981	[a] 80,549
New Caledonia, Huon Island	6,004	7,925	5,729	(b)	(b)	(b)
New South Wales	2,032	305	585	156	203	12
New Zealand	5,131	5,080	4,064	5,427	6,108	(b)
Norway [c]	1,832	4,562	1,168	.....	1,068	(b)
Ocean and Nauru islands	202,000	155,000	115,000	[d] 392,000	400,000	(b)
Portugal	.....	.....	300	1,775	1,054	(b)
Russia	(b)	(b)	(b)	(b)	(b)	(b)
South Australia	5,183	8,204	6,045	8,893	5,161	(b)
Spain	28,148	43,303	25,035	42,896	38,064	6,492
Tunis	576,000	862,494	1,075,214	1,075,180	1,800,000	1,958,000
United States	2,625,765	2,530,737	2,308,448	4,169,851	2,097,153	2,456,690
Victoria	1,549	3,438	2,521	4,290	1,566	1,114

[a] Exports.
[b] Figures not yet available.
[c] Apatite.
[d] Eighteen months, July, 1919, to December, 1920. Figures for calendar year 1920 not available.

NOTES ON FOREIGN PHOSPHATES.

In view of these world conditions the following notes on foreign phosphates are appropriate.

EGYPT.[6]

Although phosphate deposits have been discovered at many points in Egypt, only those along the coast of the Red Sea are of present commercial importance. The deposits at Koseir, El Karn, El Hamama, El Sibaia, and Sofaga are known to be valuable. That at Sofaga, 18 miles from the coast, is being developed by an English company and is said to contain over 58 per cent of tricalcium phosphate. The mine, which employs about 2,000 workmen, ships its product to the coast by means of an electric railroad, and practically all the product is being exported to Japan at present. The annual production is about 125,000 tons. The deposits at Koseir and El Sibaia are being exploited by an Italian company, which exports the product to Italy. The quantities shipped from this source in 1919–1922 were as follows: 1919, 28,000 tons; 1920, 69,000 tons; 1921, 35,000 tons; 1922 (first 9 months), 8,000 tons.

MOROCCO.[7]

In 1922 80,549 tons of phosphate rock was exported from Morocco. It is estimated that 300,000 tons will be exported in 1923 and that by 1927 a production of 1,100,000 tons will have been attained. The increase in production is being made possible by the installation of mechanical handling at Casablanca, the port. The narrow-gage railway connecting Casablanca and the mines is being changed to a broad-gage line. The influence the change will have on the movement of these phosphates is indicated by the fact that the freight rate will be reduced from 52 to 16 francs a ton.

The phosphate beds are 160 kilometers south of Casablanca, in a belt 75 kilometers long and from 5 to 35 kilometers wide. The beds are in horizontal layers several meters thick. The phosphate content is said to average from 73 to 78 per cent. Reports from disinterested sources agree that there are in this belt very extensive deposits of high-grade phosphate of lime.

For the last two years the deposits have been under the direct control of a state monopoly conducted under a board of management with wide powers vested in a head manager, which gives it the flexibility of administration enjoyed by a private industry. At the same time the enterprise has been benefited greatly by its governmental character, as that has made easy the construction of railways and the provision of port facilities, which would have taken a much longer time to arrange had private interests only been concerned.

Although the Moroccan authorities claim that a small profit is now being realized from these operations, there is reason to believe that all phosphate exported is being sold at a loss. The development of the deposits, however, and of the facilities connected with the whole enterprise is being conducted with assurance, because Europe's annual requirements of phosphate exceed 4,000,000 tons. There seems little doubt that when provisions are complete to handle production and shipments in quantity the Morocco phosphate will be able to compete successfully with the Florida product.

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[6] Am. Fertilizer, vol. 58, No. 5, p. 40, Mar. 10, 1923.
[7] Chem. and Met. Eng., Apr. 23, 1923.

SOUTH AFRICA.

According to Commerce Reports a large fertilizer plant has been completed at Somerset West, in the Cape Province, South Africa, with an annual capacity of 100,000 tons of fertilizers, which is in excess of the present requirements of the Union. The project has been financed by the DeBeers Co. Raw phosphate is imported from Christmas Island, near Java. This rock is of a white chalky nature, fairly hard, and well adapted for the production of high-grade superphosphates. South Africa has been especially backward in the use of fertilizers, with the result that the yield of crops has been very low. The fertilizing ingredient most needed is phosphoric oxide, which can now be supplied in the Union.

GERMANY.[8]

Experiments begun in 1911 at the laboratory of the Rhenania Co. in Stolberg, Germany, have developed a pyrochemical process of making raw phosphate available. The process requires a temperature of 1200°–1300° C. When an intimate mixture of tricalcium phosphate, limestone, and alkali silicate, such as phonolite, is subjected to this temperature a lime alkali phosphate of the approximate composition $(CaO)_2.(K, Na)O.P_2O_5$ is formed, together with calcium silicates and calcium aluminates. A brown homogeneous sintered clinker comes from the furnace and after cooling is ground fine. In Germany the product is called "Rhenania phosphate"; abroad it goes by the name "Vesta phosphate." The percentage of phosphoric acid in the product varies with the raw materials used. Rhenania phosphate not only does not add any acid to the soil but retains in basic form all the lime in the raw phosphate and adds thereto considerable amounts of alkalies as oxides.

This process is very similar to the Kreiss process operated by the Non-Acid Fertilizer & Chemical Co. near Lakeland, Fla. (p. 118), and the comments made regarding that process would probably apply equally well to it.

RUSSIA.

The Russian superphosphate industry is making a slow recovery after the war. Some superphosphate is being made for use in sugar-beet culture, but the management is poor and costs are high. Notwithstanding unfavorable reports that are made on various Russian industries, such as the fertilizer industry, comparative figures show an undoubted increase. The larger buyers, corporate bodies of agriculturists and beet growers, have refrained from purchasing, and no mention is made of the small buyers of mineral manures known before the war, but plans for increasing production, for increasing the use of mineral fertilizers, and for financing the proposed program are under way.[9]

Potash and phosphate are reported as occurring in the Egoryevsk district, 60 miles from Moscow on the Moscow Kazan Railway. Exploitation began in May, 1922. About 270 acres has already been investigated and a reserve of about 2,000,000 tons of phosphorite disclosed, but the entire field is much larger and has an estimated

[8] Am. Fertilizer, vol. 57, No. 13, p. 38, Dec. 30, 1922.
[9] Idem, vol. 57, No. 3, pp. 40, 67-68, Aug. 12, 1922; No. 9, pp. 34-35, Nov. 4, 1922.

reserve of 63,000,000 tons. The phosphorite occurs in two beds, the thickness of which is not stated, with a barren interval of 68 feet between. The barren ground, however, contains glauconite, and the upper phosphorite stratum contains 25 per cent of glauconite with a stated content of 10 per cent of potash (K_2O). The exploited ground is said to contain as much as 320 tons of potash to the acre. In view of conditions in Russia, such a report should be received with due allowance The deposit may, however, prove to have at least considerable local significance.[10]

JAPAN.

Japan's pre-war consumption of phosphates was estimated at 220,000 to 250,000 metric tons by the Department of Overseas Trade, London, and the demand in 1919 was placed at about 400,000 tons.[11] About 320,000 tons could be supplied from foreign sources—the south Pacific islands, Egypt, and the United States—and 48,000 metric tons from Rasa Island (south of Japan, in about the latitude of Formosa). In 1920 the United States furnished 48,963 metric tons, including 4,361 metric tons of high-grade rock. The American consul at Nagoya states that in 1920 phosphate of excellent quality was imported into Japan from Idaho, but the price was very high, owing largely to transportation charges.

According to official figures, Japan produced 19,043 metric tons of phosphates in 1913 and 57,716 tons in 1915. The production was almost doubled in 1916 and increased to 192,271 tons in 1918; in 1919, however, it dropped to 122,868 tons. The Department of Overseas Trade, London,[11] states that Rasa can produce about 200,000 tons annually, but it seems difficult to get the whole of the Rasa output shipped to Japan, in spite of the subsidy granted to the Rasa Island Phosphate Co. Japan has other sources of phosphate in the Pelew and Marshall islands, which are under its mandate, and the newly discovered Hirata Island, south of Hainan.

NAURU AND OCEAN ISLANDS.[12]

Nauru and Ocean islands, tiny specks in the Pacific a few miles south of the Equator, 2,200 miles northeast of Sydney, Australia, and directly north of New Ireland, are now (1923) being actively worked for phosphate, recent shipments having exceeded 300,000 tons a year. They are 165 miles apart, and each is the top of a high submarine mountain, the Pacific being very deep in the immediate vicinity. Each island is encircled by a coral reef on which is built a steel cantilever that discharges the phosphate into small lighters. These lighters are discharged by winches on the cargo steamer anchored a few hundred yards farther out. A longer cantilever, by means of which ships can be loaded direct from the shore, is to be installed. Most of the phosphate is shipped to Australia, and a smaller part to New Zealand and Britain. The price has been, until recently, 75 to 80s. a ton. At present the price ranges from 55s. 6d. a ton in the eastern States of Australia to 58s. 6d. in the more distant western States. It is expected that these prices will be materially reduced in the near future.

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[10] Am. Fertilizer, vol. 58, No. 5, p. 66, Mar. 10, 1923.
[11] Commerce Repts., Apr. 10, 1922, p. 114.
[12] Canadian Min. Jour., Apr. 27, 1923.

NEW ZEALAND.[13]

A new fertilizer factory has been completed at Hornby, 6 miles from Christchurch, New Zealand. Its principal product is about 35,000 tons of superphosphates, including both acid and basic types. In addition about 15,000 tons of mixed fertilizer is produced, giving a total annual output of approximately 50,000 tons. The phosphate rock used comes from Nauru and Ocean islands.

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MANSFIELD, G. R., A reconnaissance of phosphate in the Salt River Range, Wyo.: U. S. Geol. Survey Bull. 620, pp. 331–349, 1916. 30¢.

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GYPSUM.

By K. W. Cottrell.

PRODUCTION.

The quantity of gypsum mined in the United States in 1922 was 3,779,949 short tons, an increase over the output in 1921 of 31 per cent.

Of the total quantity sold crude 13 per cent was sold as agricultural gypsum and the remainder for use in Portland cement and paint and for other purposes. The quantities of agricultural gypsum sold in Kansas, Michigan, and New York were 94, 51, and 32 per cent, respectively, less than in 1921; the quantities sold in Iowa, Nevada, and Ohio were 71, 93, and 38 per cent greater than in 1921. The total sales of agricultural gypsum were 3 per cent less than in 1921. The total quantity of gypsum sold crude to Portland cement factories in 1922 was 24 per cent more than in 1921. Only one State, Oklahoma, reported decreased sales, 42 per cent. Sales in other States increased—in Michigan 14 per cent, Kansas 16 per cent, Nevada and Ohio 22 per cent each, Iowa 38 per cent, New York 44 per cent, Texas 66 per cent, and Wyoming over 300 per cent.

Sales of Keenes cement increased 52 per cent in quantity and 40 per cent in value over those in 1921. The average value per ton dropped from $16.11 to $14.75.

Plaster board, tile, and blocks were made in 16 States at plants operated by the original producers of the gypsum used in their manufacture. Plants of firms that make these products but do not mine gypsum are not included here, the gypsum they use being already accounted for as plaster sold by the original manufacturers. The figures given for boards and blocks therefore do not include the entire production of these articles in the United States. Wall board increased 62 per cent in quantity and 45 per cent in value. The average value per ton decreased from $41.76 to $37.32. Blocks and tile increased 71 per cent in quantity and 25 per cent in value. The average value decreased from $16.65 to $12.20.

Gypsum produced and sold in the United States, 1918–1922.

Year.	Crude mined (short tons).	Value of crude and calcined sold.
1918	2,057,015	$11,470,854
1919	2,420,163	15,727,907
1920	3,129,142	24,533,065
1921	2,890,784	23,700,290
1922	3,779,949	29,361,151

Gypsum produced and sold in the United States, 1921 and 1922, by States.

State.	Number of active plants reporting.	Total quantity mined (short tons).	Sold without calcining.				Sold calcined.		Total value.
			Agricultural gypsum.		For Portland cement, paint, and other purposes.		Short tons.	Value.	
			Short tons.	Value.	Short tons.	Value.			
1921.									
Arizona	1	6,985					6,544	$55,980	$55,980
California	3	40,526	(a)	(a)	(a)	(a)			151,570
Iowa	6	350,247	26,364	$98,311	58,293	$135,727	216,930	2,688,662	2,922,700
Kansas	3	92,526	(a)	(a)	28,566	89,792	50,663	574,601	665,164
Michigan	5	408,224	26,558	98,139	84,119	271,046	240,648	2,942,911	3,312,096
Nevada	4	178,275	(a)	(a)	15,558	45,477	132,837	1,471,960	1,533,037
New York	9	712,665	20,081	84,283	186,223	610,235	418,695	5,715,703	6,410,221
Ohio	3	363,905	2,645	13,493	4,344	15,179	263,879	3,163,265	3,191,937
Oklahoma	3	209,201	(a)	(a)	72,087	238,494	99,923	1,046,844	1,289,226
Texas	4	232,806	(a)	(a)	10,709	33,068	183,159	1,732,463	1,765,600
Utah	3	35,536	(a)	(a)	(a)	(a)	(a)	(c)	243,222
Wyoming	5	38,927			(a)	(a)	24,244	222,960	224,258
Other States b	13	220,961	c 29,318	c 196,676	c 78,079	c 336,091	c 159,329	c 1,818,930	1,935,279
	62	2,890,784	104,966	490,902	537,978	1,775,109	1,796,851	21,434,279	23,700,290
1922.									
Arizona	1	9,319					7,832	64,625	64,625
Arkansas	1	600			600	1,800			1,800
Iowa	6	536,905	45,062	136,451	80,452	223,187	326,937	3,786,544	4,146,182
Kansas	3	105,481	(a)	(a)	33,019	86,612	57,098	604,093	690,740
Michigan	6	471,355	13,054	40,583	94,654	250,712	275,885	2,551,822	2,843,117
Nevada	5	276,859	(a)	(a)	19,021	57,187	200,454	1,971,709	2,043,974
New York	8	1,055,302	13,708	49,537	267,822	801,848	631,735	7,955,981	8,807,366
Ohio	3	435,485	3,659	17,142	6,020	20,189	347,697	3,938,769	3,976,100
Oklahoma	5	242,932	(a)	(a)	42,279	118,997	150,627	1,532,825	1,651,837
Texas	5	221,914	(a)	(a)	(a)	(a)	242,208	2,030,688	2,081,479
Utah	3	48,338	(a)	(a)	(a)	(a)	38,684	290,546	304,562
Wyoming	5	47,222			(a)	(a)	31,386	260,819	269,574
Other States b	13	328,237	c 26,421	c 143,490	c 124,954	c 495,611	179,762	1,929,384	2,479,795
	64	3,779,949	101,904	387,203	668,821	2,056,143	2,491,265	26,917,805	29,361,151

a Included under "Other States."

b 1921: Alaska, Colorado, Montana, New Mexico, Oregon, South Dakota, and Virginia; 1922: Same States as in 1921 with California in addition. Includes also a small quantity sold by warehouses and not elsewhere accounted for.

c This figure includes also output of States entered as "(a)" above.

Gypsum produced and sold in the United States in 1922, by uses.

	Short tons.	Value.
Calcined:		
Stucco	396,990	$2,813,561
Neat plaster	1,333,261	12,126,811
Sanded plaster	80,455	1,165,771
Mixed plaster	[a] 218,650	[a] 1,911,572
Plaster of Paris, molding, casting plaster, etc	[b] 126,288	[b] 1,198,819
Keenes cement	21,991	324,316
Plaster board	42,088	945,171
Wall board	120,591	4,500,725
Partition tile	68,338	915,449
Roof tile	(c)	(c)
Special tile or blocks	44,834	368,068
Other purposes [d]	37,779	644,542
	2,491,265	26,917,805
Crude	770,725	2,443,346
	.....	29,361,151

[a] Includes small quantity of wood fiber plaster.
[b] Includes dental plaster and plaster sold to plate-glass works.
[c] Included under "Other purposes."
[d] Includes roof tile and material used for pointing up wall boards.

Keenes cement produced and sold in the United States, 1918–1922.

Year.	Manufacturers.	Short tons.	Value.
1918	5	12,823	$151,802
1919	6	15,395	200,360
1920	6	16,542	246,433
1921	7	14,430	232,457
1922	6	21,991	324,316

Gypsum produced and sold in Canada, 1918–1922.[a]

Year.	Short tons.	Value.
1918	152,287	$823,006
1919	299,063	1,215,287
1920	429,144	1,893,991
1921	386,550	1,785,538
1922	441,159	2,043,145

[a] Report on mineral production of Canada, Canada Dept. Mines.

IMPORTS.[1]

Five companies reported to the Geological Survey that they imported gypsum in 1922. These were the Connecticut Adamant Plaster Co., Higginson Manufacturing Co., J. B. King & Co., Rock Plaster Corporation, and Charles W. Priddy & Co. The quantity of gypsum reported by these five companies was less than that reported by the Bureau of Foreign and Domestic Commerce. Of the gypsum imported about 19,000 tons was sold crude. Of this quantity 84 per cent was sold for use in agriculture and the remainder to paint mills and the textile trades and as terra alba. More than 250,000 tons was sold calcined and was used principally in the manufacture of gypsum plasters. It is estimated that the total value of the gypsum

[1] The tables relating to imports were compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce.

and products sold by these five firms in 1922 was more than $4,000,000, in comparison with a business of more than $29,000,000 done by the entire industry.

Gypsum imported and entered for consumption in the United States, 1918–1922.

Year.	Unground.		Ground or calcined.		Manufactured plaster of Paris.	Keenes cement.		Total value.
	Short tons.	Value.	Short tons.	Value.		Short tons.	Value.	
1918	50,653	$55,004	6,117	$70,028	$1,765	111	$2,259	$129,056
1919	171,733	211,946	10,415	126,405	7,719	187	5,984	352,054
1920	282,486	397,942	14,921	179,191	10,282	202	5,338	592,753
1921	266,796	364,318	4,495	55,109	33,072	184	6,836	459,335
1922	409,475	523,939	1,774	32,651	55,116	403	9,636	621,342

Gypsum, crude, ground, or calcined, imported into the United States in 1922, by countries.[a]

[General imports.]

Country.	Short tons.	Value.
Canada	405,912	$539,996
Belgium		10
France	102	966
Germany	192	2,316
Italy		8
England	4,725	9,076
Hongkong	6	144
	410,937	552,516

[a] Imports after Sept. 21, under new tariff act, included only crude gypsum.

MISCELLANEOUS NOTES.

The following notes, abstracted from reports in trade journals of 1922 and 1923 and other sources, record a few of the latest important developments in the gypsum industry:

The American Cement & Plaster Co., of Salt Lake City, Utah, purchased the property of the Utah National Products Co., September 23, 1922.

The Certainteed Products Co., St. Louis, Mo., has been organized to take over the plants of the Acme Cement Plaster Co. in California, Iowa, Michigan, New Mexico, Oklahoma, Oregon, Texas, and Wyoming. The purchase also includes large deposits of gypsum in various parts of the country, amounting to several thousand acres.

The Great Western Gypsum Co., Los Angeles, Calif., began operations January 1, 1923.

The National Gypsum Co., Murfreesboro, Ark., began operations late in November, 1922.

The Oakfield Gypsum Products Co., Oakfield, N. Y., opened a mine and constructed a plant in 1922.

The Standard Gypsum Co. (Inc.), 305 Sharon Building, San Francisco, Calif., began mining and milling the gypsum deposits of the Nevada Douglas Copper Co. at Ludwig, Nev., early in the spring of 1923.

The Universal Gypsum Co., Chicago, Ill., organized December 11, 1922, has taken over the properties of the Plymouth and Iowana

gypsum companies at Fort Dodge, Iowa. These two plants have a combined capacity of over 1,000 tons a day. The properties include an electrically equipped mine, a wall-board and plaster-board plant, a gypsum-tile factory, a plaster-retarder plant, and a mortar-color plant in addition to the two mills.

The Twenty-eighth Annual Report of the Iowa Geological Survey is devoted chiefly to a comprehensive report on gypsum, its occurrence, origin, technology, and uses, with special chapters on gypsum in Iowa, by Frank A. Wilder. A valuable bibliography is also included, of which the author says that while "admittedly not complete, it is thought that not many papers of consequence, published up to 1921, have been overlooked."

The Gypsum Industries (Inc.), 844 Rush Street, Chicago, Ill., is a service bureau maintained by gypsum producers. Its work consists of research, promotion, advertising, and the preparation of specifications governing gypsum products for fireproofing and other structural purposes. An engineering department is maintained for the benefit of the public, and authentic information on the proper use and application of gypsum in building construction is given without cost or obligation. Literature on the various uses of gypsum plasters and gypsum building products is sent free upon application.

The American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Pa., has established standard specifications for calcined gypsum and for gypsum plasters; also tentative specifications (which will become standard) for gypsum plastering sand, wall board, and partition tile and for methods of testing gypsum and gypsum products.[2]

Edwin C. Eckel has issued a second edition of his book entitled "Cements, lime, and plasters," published by John Wiley & Son, New York, N. Y.

Copies of United States Geological Survey Bulletin 697, "Gypsum deposits of the United States," by R. W. Stone and others, are still available for distribution. Technical Paper 155 of the Bureau of Mines, "Gypsum products, their preparation and uses," by R. W. Stone, may be purchased at 20 cents a copy upon application to the Superintendent of Documents, Government Printing Office, Washington, D. C.

MANUFACTURERS.

MANUFACTURERS OF GYPSUM PLASTER.

HEAD OFFICES.

Acme Cement Plaster Co., 703 Frisco Building, St. Louis, Mo.
Alabastine Co., Grand Rapids, Mich.
American Gypsum Co., Port Clinton, Ohio.
Arizona Gypsum Plaster Co., Douglas, Ariz.
Beaver Products Co. (Inc.), Buffalo, N. Y.
Best Bros. Keenes Cement Co., Medicine Lodge, Kans.
Cardiff Gypsum Plaster Co., Fort Dodge, Iowa.
Centerville Gypsum Co., Centerville, Iowa.
Colorado Portland Cement Co., Ideal Building, Denver, Colo.
Connecticut Adamant Plaster Co. (importer), New Haven, Conn.
Dakota Plaster Co., Rapid City, S. Dak.
Ebsary Gypsum Co. (Inc.), 171 Court Street, Rochester, N. Y.

[2] Marani, V. C. (chief engineer Gypsum Industries), Rock Products, Dec. 30, 1922.

Empire Gypsum Co., Rochester, N. Y.
Garbutt & Orcutt, 712 Pantages Building, Los Angeles, Calif.
Globe Plaster & Mining Co., 222 Commerce Building, Kansas City, Mo.
Grand Rapids Plaster Co., Grand Rapids, Mich.
Higginson Manufacturing Co. (importer), Newburgh, N. Y.
Jumbo Plaster & Cement Co., Sigurd, Utah.
J. B. King & Co. (importer), 17 State Street, New York, N. Y.
Laramie Cement Plaster Co., Laramie, Wyo.
Lycoming Calcining Co., Williamsport, Pa.
Michigan Gypsum Co., Grand Rapids, Mich.
Nephi Plaster & Manufacturing Co., 322 Ness Building, Salt Lake City, Utah.
Niagara Gypsum Co., Buffalo, N. Y.
Northwest Gypsum Products Co., Lewistown, Mont.
Oklahoma Portland Cement Co., Denver, Colo.
Overland Cement Plaster Co., Laramie, Wyo.
Pacific Coast Gypsum Co., Tacoma, Wash.
Pacific Portland Cement Co., Pacific Building, San Francisco, Calif.
Plymouth Gypsum Co., Fort Dodge, Iowa.
Rock Plaster Corporation (importer), 40 Rector Street, New York, N. Y.
Southern Gypsum Co., North Holston, Va.
Texas Cement Plaster Co., Oklahoma City, Okla.
Three Forks Portland Cement Co., Denver, Colo.
United States Gypsum Co., 205 West Monroe Street, Chicago, Ill.
Wasem Plaster Co., Fort Dodge, Iowa.
White Star Plaster Co., 1324 Washington Building, Los Angeles, Calif.
Wyoming Cement Plaster Co., Greybull, Wyo.

MANUFACTURERS OF GYPSUM PLASTER OPERATING MORE THAN ONE PLANT.

Acme Cement Plaster Co	Grand Rapids, Mich.
	Acme, Okla.
	Acme, Tex.
	Acme, N. Mex.
	Laramie, Wyo.
	Gypsum, Oreg.
American Cement Plaster Co	Akron, N. Y.
	Gypsum, Ohio.
	Grand Rapids, Mich.
	Fort Dodge, Iowa.
	Blue Rapids, Kans.
	Acme, Tex.
Colorado Portland Cement Co	Coaldale, Colo.
	Red Butte, Wyo.
Grand Rapids Plaster Co	Grand Rapids, Mich.
	Grandville, Mich.
United States Gypsum Co	Oakfield, N. Y.
	Plasterco, Va.
	Gypsum, Ohio.
	Alabaster, Mich.
	Grand Rapids, Mich.
	Fort Dodge, Iowa.
	Blue Rapids, Kans.
	Southard, Okla.
	Eldorado, Okla.
	Piedmont, S. Dak.
	Loveland, Colo.
	Arden, Nev.
	Amboy, Calif.

MANUFACTURERS OF KEENES CEMENT.

Acme Cement Plaster Co., 703 Frisco Building, St. Louis, Mo.
American Cement & Plaster Co., Salt Lake City, Utah.
Best Bros. Keenes Cement Co., Medicine Lodge, Kans.
Nephi Plaster & Manufacturing Co., 322 Ness Building, Salt Lake City, Utah.

Pacific Portland Cement Co., 827 Pacific Building, San Francisco, Calif.
Texas Cement Plaster Co., Oklahoma City, Okla.
United States Gypsum Co., 205 West Monroe Street, Chicago, Ill.
Wasem Plaster Co., Fort Dodge, Iowa.

MANUFACTURERS OF GYPSUM PLASTER BOARD AND WALL BOARD.

American Gypsum Co., Port Clinton, Ohio.
Beaver Products Co. (Inc.), Buffalo, N. Y.
Bell, H. W., & Co., 2592 Park Avenue, New York City.
Buttonlath Manufacturing Co., Vernon and Boyle avenues, Los Angeles, Calif.
Duffy, J. P., & Co., 51st Street and Second Avenue, Brooklyn, N. Y.
Empire Gypsum Co., Rochester, N. Y.
Gypsite Fireproofing Co., 2034 Dime Bank Building, Detroit, Mich.
Hercules Plaster Board Co., Hampton, Va.
Kelley Plaster & Plaster Board Co., 261 Central Avenue, Passaic, N. J.
Key Hold Lath Co., 148 Hooper Street, San Francisco, Calif.
King, J. B., & Co., 17 State Street, New York City.
New Jersey Adamant Manufacturing Co., 79 Passaic Avenue, East Newark, N. J.
Pacific Coast Gypsum Co., 403 Perkins Building, Tacoma, Wash.
Plymouth Gypsum Co., Fort Dodge, Iowa.
Rader, Gustav, 1105 Metropolitan Avenue, Brooklyn, N. Y.
Reeb, M. A., Corporation, 597 Michigan Avenue, Buffalo, N. Y.
Rock Plaster Corporation, 381 Fourth Avenue, New York City.
Schumacher Wall Board Co., 58th Street and San Pedro and Slauson avenues, Los Angeles, Calif.
Southern Gypsum Co., North Holston, Va.
United States Gypsum Co., 205 West Monroe Street, Chicago, Ill.

MANUFACTURERS OF GYPSUM BLOCK AND TILE.

Acme Cement Plaster Co., 703 Frisco Building, St. Louis, Mo.
Alabastine Co., Grand Rapids, Mich.
American Gypsum Co., Port Clinton, Ohio.
Arizona Gypsum Plaster Co., Douglas, Ariz.
Beaver Products Co. (Inc.), Buffalo, N. Y.
Ebsary Gypsum Co. (Inc.), Rochester, N. Y.
Empire Gypsum Co., Rochester, N. Y.
King, J. B., & Co., 17 State Street, New York, N. Y.
Nephi Plaster & Manufacturing Co., 322 Ness Building, Salt Lake City, Utah.
Plymouth Gypsum Co., Fort Dodge, Iowa.
Reeb, M. A., Corporation, 597 Michigan Avenue, Buffalo, N. Y.
United States Gypsum Co., 205 West Monroe Street, Chicago, Ill.
Wyoming Cement Plaster Co., Greybull, Wyo.

MINERS.

[Gypsum sold crude only.]

American Gypsum Co., 325 Arlington Building, Rochester, N. Y.
Briggs, K. S., El Paso, Tex.
Phoenix Gypsum Co., 325 Arlington Building, Rochester, N. Y.
Simmons, Arthur, Norwich, N. Y.

BARYTES AND BARIUM PRODUCTS.

By George W. Stose.[1]

CRUDE BARYTES.

PRODUCTION AND SALES.

The crude domestic barytes sold by producers in the United States in 1922 amounted to 155,000 short tons, valued at $1,124,000, considerably more than double the quantity and value of the output in 1921. The maximum output in any year prior to the World War was about 90,000 short tons, sold in 1907. In 1913 the quantity sold was only 45,000 tons. During the war sales ranged from 109,000 to 222,000 tons. The largest quantity ever sold in any one year was 228,000 tons in 1920, shortly after the war. The slump in sales in 1921, due to general business depression, was largely overcome in 1922 by the revival of business activity, especially in the paint and lithopone industry. The reports from producers in 1922 showed in general a more optimistic view of the industry, which was slightly discounted in some districts by the shortage of labor.

About 80 per cent of the total output of domestic crude barytes in 1922 was produced in Missouri and Georgia. The production in Missouri exceeded that in Georgia by about 9,000 tons and increased over that of 1921 by about 164 per cent. As the output in Georgia increased only 132 per cent, Missouri was thus established more securely as the leading State in this industry. Tennessee was third in quantity sold, and its production of 1921 was more than doubled. In California the production increased 254 per cent.

Crude barytes produced and sold in the United States, 1901–1922.

Year.	Short tons.	Value.[a]		Year.	Short tons.	Value.[a]	
		Total.	Average.			Total.	Average.
1901–1910 (average)	55,840	$174,098	$3.12	1919	209,330	$1,727,822	$8.25
1911–1915 (average)	56,503	193,812	3.43	1920	228,113	2,142,464	9.39
1916	221,952	1,011,232	4.56	1921	66,369	531,958	8.02
1917	206,888	1,171,184	5.66	1922	155,040	1,123,950	7.25
1918	155,368	1,044,905	6.73				

[a] Value f. o. b. mine shipping point.

[1] Statistics of domestic production prepared by Mrs. E. R. Phillips. Statistics of imports compiled by J. A. Dorsey, from the records of the Bureau of Foreign and Domestic Commerce.

Crude barytes produced and sold in the United States, 1920–1922, by States.

State.	1920			1921			1922		
	Short tons.	Value.[a]		Short tons.	Value.[a]		Short tons.	Value.[a]	
		Total.	Average.		Total.	Average.		Total.	Average.
California	2,250	$20,850	$9.27	942	$5,084	$5.40	3,338	$17,707	$5.30
Georgia	84,644	790,362	9.34	24,614	191,442	7.78	57,045	468,517	8.21
Missouri	99,654	1,013,570	10.17	25,200	217,913	8.65	66,421	421,568	6.35
Tennessee	29,319	213,657	7.29	8,180	61,148	7.48	16,642	124,204	7.46
Other States [b]	12,246	104,025	8.49	7,433	56,371	7.58	11,594	91,954	7.93
	228,113	2,142,464	9.39	66,369	531,958	8.02	155,040	1,123,950	7.25

[a] Value f. o. b. mine shipping point.
[b] States having less than 3 producers each are grouped together to avoid disclosing confidential information. 1920: Alabama, Illinois, Kentucky, Nevada, North Carolina, South Carolina, Virginia, and Wisconsin; 1921: Alabama, Illinois, North Carolina, South Carolina, and Virginia; 1922: Alabama, Idaho, Illinois, North Carolina, and South Carolina.

STOCKS.

The quantity of ore stored at the mines at the end of 1922 is estimated at 17,000 tons. Apparently the stock at the end of 1921 was much larger—about 38,950 tons according to revised figures. More than one-third of the stock on hand at the end of 1922 was reported at mines in Georgia, and a little less than one-third in Missouri. Tennessee had about half of the remainder. The records are not accurate enough to be stated in figures.

IMPORTS.

More than 23,000 short tons of crude barytes (not including ground barytes), valued at $104,680, was imported in 1922. This is more than twice the quantity imported in 1921, but slightly less than that for 1920. This material was all purchased for use in plants in the eastern parts of the United States, and most of it came from Germany.

Crude barytes imported into the United States, 1901–1922.

Year.	Short tons.	Value.[a]		Year.	Short tons.	Value.[a]	
		Total.	Average.			Total.	Average.
1901–1910 (average)	11,224	$38,008	$3.39	1919	118	$594	$5.03
1911–1915 (average)	21,833	40,436	1.85	1920	24,874	146,858	5.90
1916	17	245	14.41	1921	11,054	59,371	5.37
1917	6	63	10.50	1922	23,239	104,680	4.50
1918							

[a] Value at port of shipment, on which duty is levied. Does not include railroad and ship freight charges to this country or import duty.

MARKETS.

Barytes is used in the manufacture of barium products, such as lithopone, refined ground barytes, and barium chemicals. Many of the larger manufacturing plants operate barytes mines, but the quantity of ore thus obtained is in general insufficient for the needs of the plants, and there has been a constant demand and ready

market for high-grade ore, both domestic and imported. In 1922 the barium industries consumed 167,842 short tons of crude barytes ore, 56 per cent of which was used in making lithopone, 29 per cent in ground barytes, and 15 per cent in barium chemicals. More than half the total amount used was sold in the vicinity of Philadelphia, in the States of Delaware, New Jersey, New York, and Pennsylvania. About one-fourth was sold or used in Missouri. Less than 15 per cent of the total used was imported. The quantity of ore used in 1922, although greatly in excess of that used in 1921, is considerably less than the yearly consumption for 1916 to 1920.

Crude barytes (both domestic and imported) used in the manufacture of barium products in the United States, 1916–1922, in short tons.[a]

Year.	Ground barytes.	Lithopone.	Barium chemicals.	Total.
1916	75,507	71,898	38,283	185,688
1917	60,132	86,065	49,842	196,039
1918	62,440	85,282	38,041	185,763
1919	64,922	103,688	32,976	201,586
1920	79,052	113,181	37,210	229,443
1921	28,296	61,359	10,952	100,607
1922	48,280	94,259	25,303	167,842

[a] Compiled from reports made by the manufacturers of barium products.

Barytes used by manufacturers of barium products in 1922, in short tons.

State.	Product manufactured.	Plants.	Barytes used.
Missouri	Ground barytes and lithopone	4	40,266
New Jersey	Lithopone and chemicals	3	25,658
Illinois	do	5	12,068
Pennsylvania	do	4	58,764
Delaware	Lithopone		
New York	Chemicals		
Maryland	Lithopone	4	12,676
Georgia and South Carolina	Ground barytes		
West Virginia	Chemicals		
California	Ground barytes, lithopone, and chemicals	4	18,410
Tennessee	Chemicals		
		24	167,842

PRICES.

The barytes operators throughout the country in general received a lower price for their ore in 1922 than they did in 1921. The average value at the mines for all the barytes ore mined and sold or used in the United States in 1922 was $7.25 a ton, a decrease of 77 cents a ton from the average in 1921. This is $2.14 less than the average received in 1920, when the peak was reached. It is, however, more than double the average value in 1915. The averages given above are obtained from the reports of the operators, some of whom give actual receipts from sales, while others report a value agreed upon between the mining and manufacturing branches of their companies.

The average value in Georgia was $8.21. The average in Missouri was $6.35, and this is the first time since 1914 that values have averaged lower in Missouri than in Georgia. In fact, the Missouri average value for 1922 is lower than that of most of the other States.

CONSUMPTION.

The consumption of crude barytes in the United States is estimated by adding the quantity of ore imported to the quantity mined and sold. No barytes was exported. Ore bought by manufacturers of barium products but not yet consumed in their plants is for the present purpose regarded as consumed and is included in the following table. There was 130 per cent more crude barytes consumed in 1922 than in 1921, but not so much as the average annual consumption in the years 1916 to 1920.

Crude barytes consumed in the United States, 1913–1922, in short tons.

Year.	Domestic barytes sold or used.	Imports.	Consumption.	Year.	Domestic barytes sold or used.	Imports.	Consumption.
1913	45,298	35,840	81,138	1918	155,368	.....	155,368
1914	52,747	24,423	77,170	1919	209,330	118	209,448
1915	108,547	2,504	111,051	1920	228,113	24,874	252,987
1916	221,952	17	221,969	1921	66,369	11,054	77,423
1917	206,888	6	206,894	1922	155,040	23,239	178,279

BARYTES INDUSTRY BY STATES.

Alabama.—The Alabama Barytes Co. (Inc.), a new concern, began operating a deposit near Harpersville, Shelby County, Ala., in November, 1922, and shipped some ore. The Bertha Mineral Co., the only other active operator in the State, increased the shipments from its mine near Angel, Calhoun County. Barytes ore has been shipped continuously since 1914 from deposits in the north-central part of Alabama, and more was shipped in 1922 than in any previous year.

Alaska.—A small quantity of barytes was shipped from a deposit on Lime Point, on the west coast of Prince of Wales Island, Alaska, in 1915. No further shipments have been made, and the mine is closed.

California.—Barytes ore has been produced in California continuously since 1914, except in 1918. More ore was produced there in 1922 than in any previous year, and more than three and a half times as much was sold as in 1921. The three producing mines, one each in Mariposa, Nevada, and Shasta counties, were operated by the Western Rock Products Co., William Maguire, and H. C. Austin.

Colorado.—The deposit near Canon City, Custer County, Colo., operated in 1916 as a mineral claim by A. L. Taylor, has been abandoned by him.

Georgia.—Barytes ore has been produced in Georgia continuously since 1907, and the high mark of production, 111,300 short tons, was reached in 1917. The sales of ore in 1922 were 132 per cent greater than in 1921. The mines in operation in 1922 are all in the Cartersville district. Three of the operators, the Bertha Mineral Co., the National Pigments & Chemical Co., and Thompson, Weinman & Co., mined ore largely for their own use. The New Riverside Ocher Co. sold its product.

Idaho.—Interest was shown in deposits in Blaine County, Idaho, by experimental shipments of ore made by J. L. Day and by prospecting of other deposits in the vicinity.

Illinois.—Barytes ore has been produced in Illinois every year since 1919 from a deposit near Golconda, Pope County, where barytes is associated with fluorspar. Shipments of ore from this deposit were made by the Illinois Barite Co. in 1922.

Kentucky.—Barytes ore was produced in Kentucky in 1903, and a small production was reported annually up to 1911. From 1914 to 1920 production was again continuous. The largest output was in 1916, when 11,000 tons was sold. There has been no production since 1920. The barytes in the deposits near Salem recently prospected, as in other deposits in this part of the State and the adjacent part of Illinois, is intimately mixed with fluorspar.

Missouri.—Missouri has had a prominent part in the mining of barytes in the United States since 1882. The greatest output, 99,654 tons, valued at $1,013,570, was reached in 1920. The output in 1922 was only about two-thirds of that of 1920 but was over two and a half times that of 1921. Washington County reported about 80 per cent of the whole Missouri output. Jefferson and St. Francois followed in amount of sales. Most of the ore was bought by the following manufacturers of barium products:

Barium Products Corporation, Carbondale, Ill.
Chicago Copper & Chemical Co., Chicago, Ill.
Midland Chemical Co., Chicago, Ill.
National Pigments & Chemical Co., St. Louis, Mo.
New Jersey Zinc Co., New York, N. Y.
Point Milling & Manufacturing Co., Mineral Point, Mo.
Sherwin-Williams Co., Cleveland, Ohio.

The more active producers of barytes ore in Missouri in 1922 were as follows:

American Barytes Corporation, Eldon.
Clarence Bess, Bonne Terre.
Mrs. Agnes M. Boaz, Mineral Point.
T. F. Blount & Co., Potosi.
Bust Bros., Tiff.
Mrs. S. C. Coleman, Racola.
C. P. De Lore, Carondelet Station, St. Louis.
T. L. Dapron, Vineland.
John Degonia, Baryties.
Buren Duckworth, St. Clair.
Evans & Russell, Potosi.
Martin F. Higgins, Potosi.
Johnson Bros., Fletcher.
John O. Long & Sons, Cadet.
Hugh McGregor, 5431 Cabanne Street, St. Louis.
National Pigments & Chemical Co., St. Louis.
Point Milling & Manufacturing Co., Mineral Point.
Anthony Recar, Cruise.
C. C. Rose & H. O. Hollow, Sullivan.
St. Joe Lead Co., Bonne Terre.
J. W. Settle Co., Potosi.
Southeast Missouri Lead Co., 207 North Twelfth Street, St. Louis.
A. E. Stocking, De Soto.
J. W. Towl, Potosi.
Valle Mining Co., 112 North Fourth Street, St. Louis.
John Wallace, Mineral Point.
P. C. Walton & Co., Mineral Point.
Washington Land & Mining Co., 315 Washington Avenue, St. Louis.
Mrs. M. J. Waugh, Mineral Point.
George V. Welch, Vineland.
C. M. Wells, Bonne Terre.
White & Bro., Potosi.

Barytes produced and sold in Missouri, 1922, by counties.

County.	Mines.	Short tons.	Value.
Washington	43	53,136	$338,218
Jefferson	5	1,187	6,890
St. Francois	6	637	4,593
Cole and Franklin	4	975	5,112
Miller and Morgan	3	291	2,017
Undistributed [a]	(b)	10,195	64,738
	61+	66,421	421,568

[a] Estimated from purchases of Missouri ore by barium-product manufacturers.
[b] Number not known.

Nevada.—Barytes ore was mined and shipped from mines in Esmeralda and Mineral counties, Nev., from 1916 to 1920, but none has been produced since.

New Mexico.—Barytes ore was mined in 1918 in Sierra and Dona Ana counties, N. Mex., and a trial shipment was made. None has been produced since.

North Carolina.—Barytes ore has been produced continuously in North Carolina since 1901. The largest shipments were made in 1902, when 14,679 tons was sold. In 1922 ore was produced by two operators in Madison County—the Rollin Chemical Co., of Charleston, W. Va., and Ben W. Gahagan, of Stackhouse, N. C.

South Carolina.—The Cherokee Chemical Co. (Inc.) increased its production of barytes ore from its mine near Kings Creek, Cherokee County, S. C., in 1922. This company, which has been the only operator in South Carolina for some years, has mined ore every year since 1913.

Tennessee.—Barytes has been mined and shipped in Tennessee continuously since 1900. The highest output for the State was 34,700 short tons, in 1919. The production in 1922 was an increase of more than 100 per cent over that of 1921. In 1922 the Durex Chemical Corporation, H. B. Gilman, the Krebs Mining Co., H. J. Moore, the National Barium Corporation, and J. J. Fitzgerald mined ore in Loudon, McMinn, and Monroe counties, but most of the output came from Monroe County.

Virginia.—Barytes has been mined continuously in Virginia apparently since 1889, and it was produced as early as 1845. The largest recorded quantity shipped in a year was 17,013 tons in 1891. No ore was sold in Virginia in 1922, but the Bertha Mineral Co. continued development work at its mine at Tosches, Pittsylvania County.

Wisconsin.—A small quantity of barytes ore was mined near Cuba City, Lafayette County, Wis., in 1918 to 1920, but none has been sold since. The ore is associated with lead in slate.

BARIUM PRODUCTS.

The barium-products industry in the United States had a revival of activity in 1922, the year's production showing an increase of 63 per cent over that of 1921 and falling below the production of 1920, the largest since 1915, by only 18 per cent. The production of barium chemicals made the greatest advance, increasing 153 per cent.

Barium products made from domestic and imported crude ores and sold in the United States, 1921–22.

Product.	1921			1922		
	Short tons.	Value.		Short tons.	Value.	
		Total.	Average.		Total.	Average.
Ground barytes	27,661	$622,871	$22.52	46,176	$933,722	$20.22
Lithopone	55,016	6,681,563	121.45	83,360	9,214,040	110.53
Barium chemicals[a]	5,487	412,275	75.14	13,901	1,562,216	112.38
	88,164	7,716,709	87.53	143,437	11,709,978	81.64

[a] Barium chemicals manufactured from secondary barium products bought in open market are not included in table.

REFINED GROUND BARYTES.

Uses.—Barytes is ground to very fine powder, leached with acid, and washed for use as a pigment, a filler, and an inert base. Most barytes is refined by flotation on a stream of water, whereby only the most impalpable powder is obtained. As a pigment it is used chiefly in interior flat white or light-colored paints. As a filler it is extensively used in rubber goods, linoleum, oilcloth, highly glazed paper, and similar white glazed articles. It forms an inert base on which dyes are precipitated to make lakes or colored paints. Ground barytes has also been used in making brick for the construction of X-ray laboratories, in place of a lining of sheet lead, to prevent the rays from escaping and doing possible injury.

Production.—Six companies operated seven plants for grinding barytes in the United States in 1922, as follows:

Companies grinding barytes in 1922.

Company.	Location of plant.
Western Rock Products Co., San Francisco, Calif.	San Francisco, Calif.
Thompson, Weinman & Co., New York, N. Y.	Cartersville, Ga.
National Pigments & Chemical Co., St. Louis, Mo.	Do.
Do.	St. Louis, Mo.
American Barytes Corporation, Eldon, Mo.	Eldon, Mo.
Point Milling & Manufacturing Co., Mineral Point, Mo.	Mineral Point, Mo.
Cherokee Chemical Co., Kings Creek, S. C.	Kings Creek, S. C.

The output in 1922 increased 67 per cent over that of 1921 but was 30 per cent less than that of 1920. Of the total ground barytes sold during the year 84 per cent was produced in Missouri. The National Pigments & Chemical Co. was the largest producer.

Ground barytes sold by domestic producers in 1922, by States.

State.	Plants.	Short tons.	Value.	
			Total.	Average.
Missouri	3	38,827	$823,157	$21.20
California, Georgia, and South Carolina	4	7,349	110,565	15.04
	7	46,176	933,722	20.22

Price.—The average value at the plant of domestic ground barytes sold in the United States in 1922 was $20.22 a ton, which is $2.30 less than the value in 1921. Prices in 1922 in the New York market for domestic western floated prime white ground barytes f. o. b. mills, as quoted in the Oil, Paint, and Drug Reporter, were $23 and more a ton from January to November and $26 and more in December. Domestic southern off-color ground barytes in bulk was quoted at $15 to $17 a ton from January to November and at $15 to $20 in December. Foreign prime white barytes brought $32 to $35 a ton during the year.

LITHOPONE.

Uses.—Lithopone is a pigment prepared chemically from barytes and zinc. It is an intimate mixture of chemical precipitates of barium sulphate and zinc sulphide in the proportion of about 70 per cent sulphate and 30 per cent sulphide. It is of exceedingly fine grain and is used not only in paint but as a filler in rubber goods, linoleum, oilcloth, window shades, and certain kinds of paper.

Production.—The following 13 plants made lithopone which was sold in 1922, though one sold only stock made in the preceding year.

Manufacturers selling lithopone in 1922.

Company.	Location of plant.
Metals & Chemicals Extraction Corporation, Oakland, Calif.	Oakland, Calif.
Krebs Pigment & Chemical Co., Newport, Del.	Newport, Del.
Midland Chemical Co., Chicago, Ill.	Argo, Ill.
Sherwin-Williams Co., Cleveland, Ohio	Chicago, Ill.
Collinsville Zinc Corporation, 1000 Times Building, St. Louis, Mo.	Collinsville, Ill.
Glidden Co., St. Helena, Baltimore, Md.	St. Helena, Md.
Mineral Refining & Chemical Corporation, St. Louis, Mo.	St. Louis, Mo.
E. I. du Pont de Nemours & Co., Wilmington, Del	Newark, N. J. Philadelphia, Pa.
Grasselli Chemical Co., Cleveland, Ohio	Grasselli, N. J.
United Color & Pigment Co., Newark, N. J.	Newark, N. J.
New Jersey Zinc Co., New York, N. Y.	Palmerton, Pa. (2 plants).

The quantity of lithopone sold in 1922 was about 50 per cent more than was sold in 1921 and was more than was manufactured and sold in any previous year except 1920, when the sales were 6,000 tons greater than in 1922. Pennsylvania led in the quantity sold, and New Jersey was second. Of the total output of the country 85 per cent was sold in Pennsylvania, New Jersey, and Delaware together, as the industry is largely centered around Philadelphia.

Lithopone manufactured and sold in the United States, in 1922, by States.

State.	Plants.	Short tons.	Value.	
			Total.	Average.
Pennsylvania and Delaware	4	50,602	$5,665,646	$111.96
New Jersey	3	20,077	2,275,085	113.32
Illinois	3	7,227	724,711	100.28
Maryland, Missouri, and California	3	5,454	548,598	100.59
	13	83,360	9,214,040	110.53

Price.—The average value reported by domestic manufacturers at their plants in 1922 was $110.53 a ton, which is nearly $11 less than in 1921 and more than $29 less than in 1920. Values in 1922 ranged from $95.68 to $126.32 a ton. Prices for lithopone delivered in New York in barrels in car lots, quoted in the Oil, Paint, and Drug Reporter, were 6¼ cents or more a pound from January to October 23 and 6 to 6½ cents from October 30 to December 25.

Lithopone manufactured and sold in the United States, 1915–1922.

Year.	Short tons.	Value.		Year.	Short tons.	Value.	
		Total.	Average.			Total.	Average.
1915	46,494	$3,760,472	$80.88	1919	78,365	$10,218,850	$130.40
1916	51,291	5,798,927	113.06	1920	89,373	12,484,925	139.69
1917	63,713	7,406,896	116.25	1921	55,016	6,681,563	121.45
1918	62,403	7,923,276	126.97	1922	83,360	9,214,040	110.53

BARIUM CHEMICALS.

Production.—The quantity of barium chemicals made in the United States from barytes ore and sold in 1922 was 153 per cent greater than the sales in 1921 but did not equal the yearly sales in 1916 to 1920. These barium chemicals were made by the following eight plants in seven States in 1922:

Manufacturers of barium chemicals in 1922.

Company.	Location of plant.
Metals & Chemicals Extraction Corporation, Oakland, Calif.	Oakland, Calif.
Chicago Copper & Chemical Co., Chicago, Ill.	Blue Island, Ill.
Barium Products Corporation, Carbondale, Ill.	Carbondale, Ill.
Grasselli Chemical Co., Cleveland, Ohio.	Grasselli, N. J.
Titanium Pigments Co. (Inc.), New York, N. Y.	Niagara Falls, N. Y.
E. I. du Pont de Nemours & Co., Wilmington, Del.	Philadelphia, Pa.
Durex Chemical Corporation, New York, N. Y.	Sweetwater, Tenn.
Rollin Chemical Corporation, New York, N. Y.	South Charleston, W. Va.

Two new companies, the Barium Products Corporation, of Carbondale, Ill., and the Titanium Pigments Co., of New York, N. Y., reported the production of barium chemicals for the first time. Three plants produced barium sulphate, which formed more than 40 per cent of the total chemicals sold. Barium carbonate and barium chloride were each made in four plants. Other chemicals were made by only one or two plants each.

Barium chemicals of domestic manufacture sold, 1915–1922, in short tons.

Chemical.	1915–1918 (average).	1919	1920	1921	1922		
					Short tons.	Value.	
						Total.	Average per pound.
Barium carbonate	6,373	7,135	7,484	1,956	2,281	$163,636	$0.036
Barium chloride	3,787	4,509	3,084	(a)	2,022	163,749	.04
Barium sulphate (blanc fixe)	5,100	5,227	8,046	2,471	5,740	392,793	.034
Other barium chemicals [a]	2,566	3,142	2,146	1,060	3,858	842,038	.109
	17,826	20,013	20,760	5,487	13,901	1,562,216	.056

[a] The quantities of chemicals manufactured in less than three plants are combined in the table to avoid divulging confidential information, as follows: 1915–1918: Binoxide, hydroxide, nitrate, and sulphide; 1919: Binoxide, nitrate, and sulphide; 1920: Binoxide, hydroxide, nitrate, and sulphide; 1921: Chloride, hydroxide, and sulphide; 1922: Binoxide, hydroxide, sulphydrate, sulphide, and titanox.

Price.—The average value reported by manufacturers for barium carbonate in 1922 was 47 cents a hundred pounds less than was received in 1921 and 28 cents less than in 1920. Barium chloride brought 97 cents more a hundred pounds than it did in 1921 and $1.04 less than in 1920; barium sulphate, 23 cents less than in 1921 and 74 cents more than in 1920. The following table presents market prices quoted in New York:

Prices of barium chemicals quoted in New York wholesale market, 1921 and 1922.[a]

Chemical.	Unit.	1921	Jan. 1, 1922.	Dec. 31, 1922.
Barium chlorate, in kegs	Pound	$0.40 – $0.45	$0.40 – $0.450	$0.14 – $0.15
Barium chloride (white crystals), in bags	Short ton	43.00 –100.00	52.00 – 55.00	90.00 –100.00
Barium dioxide	Pound	.22½– .25	.22½– .25	.22 – .29
Barium nitrate, in casks	do	.07 – .13½	.07 – .09½	.08½– .10¼
Barium sulphate (blanc fixe), dry, in barrels	do	.0²¾	.04½	.04½
Barium sulphate (blanc fixe), pulp	Short ton	30.00 – 60.00	40.00 – 50.00	40.00 – 50.00
Barium binoxide, in drums	Pound		.20 – .23	.18 – .20

[a] Oil, Paint, and Drug Reporter.

IMPORTS AND EXPORTS.

More barium products were imported in 1922 than in any previous year. The increases were shown in all classes of barium products except barium chloride, in which there was a decrease. More than four and a half times the quantity of ground barytes imported in 1921 was received in 1922, and more than twice the quantity of lithopone, blanc fixe, precipitated barium carbonate, and ground natural barium carbonate.

Barium compounds imported for consumption in the United States, 1913–1922.

[Value at port of shipment.]

Year.	Ground barytes.			Lithopone.[a]		
	Short tons.	Value.		Pounds.	Value.	
		Total.	Average.		Total.	Average.
1913	5,463	$38,155	$6.98	4,725,000	$146,474	$0.03
1914	4,323	30,483	7.05	7,980,000	271,310	.03⅖
1915	1,308	10,736	8.21	4,087,826	137,816	.03⅜
1916	147	2,072	14.10	4,681,560	405,730	.08⅔
1917	88	1,743	19.81	448,000	29,199	.06½
1918						
1919				1,477,296	122,708	.08⅓
1920	274	3,017	11.01	3,427,321	263,240	.07⅞
1921	1,002	16,942	16.91	10,493,938	432,019	.04
1922	4,696	59,453	12.66	21,525,824	885,671	.04

Year.	Barium binoxide.			Blanc fixe (precipitated barium sulphate).		
	Pounds.	Value.		Pounds.	Value.	
		Total.	Average.		Total.	Average.
1913	4,173,188	$239,000	$0.05¾	4,883,014	$62,785	$0.01¼
1914	5,741,752	332,709	.05⅘	2,847,791	32,619	.01
1915	2,397,359	218,776	.09	1,441,989	18,501	.01¼
1916	106,863	6,590	.06⅕	676,908	17,810	.02⅝
1917				229,040	3,333	.01½
1918						
1919				1,285	90	.07
1920	501,673	64,447	.12⅘	329,299	8,485	.02⅗
1921	1,337,972	127,631	.09½	1,538,383	22,470	.01½
1922	2,018,194	189,334	.09⅖	4,373,206	76,445	.01¾

Year.	Artificial barium carbonate (chemically precipitated).			Natural barium carbonate (ground witherite).		
	Pounds.	Value.		Pounds.	Value.	
		Total.	Average.		Total.	Average.
1913	4,085,878	$38,949	$0.01	1,795,396	$13,116	$0.00¾
1914	3,065,362	28,221	.01	1,187,284	8,084	.00¾
1915	286,504	2,786	.01	1,211,310	12,165	.01
1916				1,607,352	18,169	.01
1917	107,092	1,554	.01½	1,186,260	17,321	.01½
1918				723,676	14,134	.02
1919	8,549	2,666	.31⅕	224,000	4,739	.02
1920	951,501	37,462	.03⅘	3,020,304	61,284	.02
1921	4,475,225	80,603	.01⅘	1,336,712	25,188	.01⅘
1922	10,424,636	210,250	.02	2,943,387	39,114	.01⅗

[a] Prior to October, 1913, imported as zinc sulphide white. Figures for 1913 and 1914 have been adjusted on basis of some lithopone having been listed under that name. Since 1914 apparently no lithopone has been imported as zinc sulphide white.

Barium compounds imported for consumption in the United States, 1913–1922—Contd.

Year.	Barium chloride.			Total.	
	Pounds.	Value.		Short tons.	Value.
		Total.	Average.		
1913	3,725,239	$37,620	$0.01	17,159	$576,099
1914	5,921,370	68,866	.01⅛	17,696	772,292
1915	2,561,056	31,295	.01⅛	7,302	432,075
1916	6,614	608	.09⅛	3,686	450,979
1917				1,074	53,150
1918				362	14,134
1919	1,099,686	19,846	.01⅘	1,406	150,049
1920	3,190,255	151,778	.04⅗	5,984	589,713
1921	4,372,939	72,621	.01⅔	12,780	777,474
1922	3,923,737	112,785	.02⅘	27,301	1,573,052

Prior to 1922 barium products had not been exported in appreciable amount, and no separate record of the exports was kept. In 1922 there were 3,231,722 pounds (1,616 short tons) of lithopone, valued at $169,982, exported. Although this is less than 2 per cent of the total lithopone made and sold in the United States, it may mark the beginning of a much larger foreign commerce in this and other barium products.

MICA.

By B. H. Stoddard.

INTRODUCTION.

That the mica industry in 1922 showed a decided tendency to recuperate from its depressed condition in 1921 is indicated by reports of production and sales of mica received by the Geological Survey from producers and others in the mica business. The production of both sheet and scrap mica increased in total quantity and value. The average value of uncut sheet mica increased from 16 cents a pound in 1921 to 18 cents in 1922, and the average value of scrap mica decreased from $22 a ton in 1921 to $17 in 1922.

NATURE AND OCCURRENCE.

Deposits of white mica (muscovite) of commercial value occur only in pegmatite, an igneous rock similar to granite in composition but much coarser grained. The chief minerals of this rock are quartz, feldspar, and mica, but it contains smaller quantities of other minerals, such as tourmaline, garnet, and beryl. Outcrops of pegmatite are in many places indicated by projecting masses or loose fragments of compact white quartz. The country rocks of most pegmatites that carry sheets of mica of commercial quality are metamorphic rocks, mainly mica schist and gneiss. In some occurrences the pegmatite follows the planes of schistosity of the country rock for considerable distances; in others it cuts across the schistosity. Many pegmatite masses are very irregular in size, shape, and continuity, and some form ledges and lens-shaped bodies of considerable extent. They range in thickness from a fraction of an inch to many yards and in length from two or three times to more than a thousand times their thickness.

Commercial sheet mica is generally scattered irregularly throughout the pegmatite, though in a few occurrences it follows well-defined and regular leads. No definite rule can be laid down for guidance in exploring a pegmatite mass for commercial sheet mica. Each occurrence must be studied in detail, and the particular portion of the pegmatite suitable for mining mica must be determined by actual experience.

Mica is found on the surface as well as at various depths. Much of that found near the surface is weathered and clay-stained, and the weathered zone may extend some distance below the surface. In some sections of the country, however, sheet mica in good condition is found practically on the surface, very little weathering having taken place.

The scales of mica in micaceous sandstone and shale are too small and too scarce to be of any commercial value. Many of the metamorphic rocks, such as gneiss and schist, contain more mica than sandstone or shale, but here, too, the small size of the mica scales and the impracticability of separating them from the abundant quartz and other hard minerals present has so far rendered such occurrences of doubtful value as a source of scrap mica.

Sheet mica mined for commercial purposes is generally found in irregular blocks or imperfect large crystals, which may be rudely hexagonal. Only a small proportion of the mica blocks, averaging about 10 per cent, contain marketable sheets.

More detailed information concerning the nature and occurrence of mica will be found in the Geological Survey's Bulletin 740, "Mica deposits of the United States," by D. B. Sterrett.

PRODUCTION.

The total sales of uncut sheet mica in the United States for 1922, as reported to the Geological Survey, were 1,077,968 pounds (539 short tons), valued at $194,301, representing increases over 1921 of 45 and 64 per cent, respectively. The scrap mica sold amounted to 6,641 short tons, valued at $114,045, an increase in quantity of 158 per cent and in value of 101 per cent. Alabama, Connecticut, North Carolina, and Virginia are the States that showed increases in the quantity of uncut sheet mica sold, and all States except New Hampshire reported increases in the quantity of scrap mica sold. New Hampshire practically maintained its status of 1921, which was a 73 per cent increase in quantity over 1920. The total quantity of scrap mica sold was the greatest on record, and the total value was exceeded in only one year, 1920, when it was $167,017. Figures for mica production were first recorded by the United States Geological Survey for 1880.

The producing States in 1922 were North Carolina, New Hampshire, Virginia, New Mexico, Georgia, South Dakota, Alabama, Colorado, Connecticut, and South Carolina, named in order of total value of mica sold.

The Mica Products Co., of Denver, Colo., has reported to the Geological Survey (August, 1923), through its general manager, Mr. W. B. Thomas, that its propery, 7 miles east of Westcliffe, Custer County, Colo., is under development preparatory to marketing its product, jefferisite. This mineral is a hydrated mica called vermiculite and is said, after heating and exfoliation, to be suitable for various purposes, such as fire brick, wall board, refrigerating, and insulation for steam pipes. It is also said to be useful in paint and rubber, and experiments for using it in the manufacture of dynamite are contemplated. The present developments consist of two shafts 30 and 35 feet deep, open cuts, and 10-foot holes showing seven different veins extending the length of the property, 1,320 feet.

The figures for sheet mica shown in the following table represent uncut sheet and punch mica. A very small quantity of splittings is also included as uncut sheet.

Mica produced and sold in the United States, 1918–1922.

Year.	Sheet mica.		Scrap mica.		Total.	
	Pounds.	Value.	Short tons.	Value.	Short tons.	Value.
1918	1,644,200	$731,810	2,292	$33,130	3,114	$764,940
1919	1,545,709	483,567	3,258	58,084	4,031	541,651
1920	[a] 1,683,480	[a] 546,972	5,723	167,017	[a] 6,565	[a] 713,989
1921	[a] 741,845	[a] 118,513	2,577	56,849	[a] 2,948	[a] 175,362
1922	[a] 1,077,968	[a] 194,301	[b] 6,641	[b] 114,045	[a b] 7,180	[a b] 308,346

[a] The figures for sheet mica in 1920, 1921, and 1922 represent uncut sheet mica exclusively. In previous years the totals have included some cut sheet mica.
[b] Includes mica derived from mica schist.

Mica sold by chief producing States, 1918–1922.

Year.	Sheet mica.			Scrap mica.		Total.	
	Pounds.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
North Carolina:							
1918	941,200	471	$460,450	1,046	$12,930	1,517	$473,380
1919	1,021,306	511	331,498	1,639	32,338	2,150	363,836
1920	1,084,946	542	405,654	2,823	91,653	3,365	497,307
1921	230,532	115	51,851	1,353	30,496	1,468	82,347
1922	544,495	272	119,767	[a] 4,205	[a] 65,923	[a] 4,477	[a] 185,690
New Hampshire:							
1918	376,900	188	106,200	530	7,040	718	113,240
1919	235,724	118	90,915	738	13,356	856	104,271
1920	284,862	142	83,811	435	12,877	577	96,688
1921	491,743	246	63,249	537	10,613	783	73,862
1922	475,647	238	63,240	238	5,838	476	69,078
Virginia:							
1918	78,500	39	46,200	404	4,280	443	50,480
1919	[b]	[b]	[b]	578	7,811	[b]	[b]
1920	179,339	90	26,189	[b]	[b]	[b]	[b]
1921	[b]	[b]	[b]	[b]	[b]	[b]	[b]
1922	43,449	22	6,577	296	9,718	318	16,295
Georgia:							
1918	208,200	104	77,300	40	2,750	144	80,050
1919	47,018	24	19,682	51	778	75	20,460
1920	50,095	25	13,692	101	3,015	126	16,707
1921	12,730	6	2,640	75	1,700	81	4,340
1922	8,818	4	4,083	224	7,247	228	11,330
Alabama:							
1918	11,800	6	3,150			6	3,150
1919	[b]	[b]	[b]			[b]	[b]
1920	81,458	41	16,401	222	5,234	263	21,635
1921							
1922	[b]	[b]	[b]	[b]	[b]	[b]	[b]

[a] Includes mica derived from mica schist.
[b] The figures may not be given, as there were less than three operators.

The following table is based on an aggregate of about 93 per cent of the total production of sheet mica. The figures include all qualities from clear to stained.

Uncut sheet mica sold in the United States in 1922, by sizes.

Size.	Pounds.	Percentage.	Percentage, with punch omitted.
Punch	856,408	85	.....
1½ by 2 inches	38,547	4	26
2 by 2 inches	30,030	3	20
2 by 3 inches	38,848	4	26
3 by 3 inches	13,168	1	9
3 by 4 inches	9,581	1	6
Larger sizes	19,115	2	13
Splittings	(a)	(a)	(a)
	[b] 1,005,697	100	100

[a] Splittings may not be shown, as there were less than three producers. The quantity was small.
[b] This figure represents about 93 per cent of the total for the United States.

MINING.

Deposits of mica are very irregular, and the method of mining them varies accordingly. If the mica is rather evenly distributed ordinary methods of mining, by shafts, adits or tunnels, drifts, and stopes, can be employed; if the mica is scattered, stopes and other workings are more irregular; and in mining the granitic micas the total quantity of mica is so small a proportion of the vein material as to suggest the type of mining known as "gophering" or "hogging," which is excavating for the purpose of getting what is available, without reference to any system of development. In such workings the waste rock is left to accumulate because of the difficulty of removing it through the small tunnels and openings, and this method soon becomes a hindrance to future development. It is used in some parts of the South, however, and is the only method that can be employed in some mines.

In some large masses of pegmatite regular quarry methods may be used. This is common in the New England mica mines, where mica is mined in open quarries and derricks and inclined tracks are used to remove ore and waste.

Great care is necessary in mining mica to avoid drilling through the crystals or shattering them by heavy charges of powder. Hand drilling is employed in the smaller mines, and some operators use hammer drills for which compressed air is supplied by steam, gasoline, or electrically operated compressors. In blasting only small charges of low-grade dynamite (usually about 40 per cent strength) should be used around a pocket of mica.

As a general rule a mica prospect should be opened by cuts, shafts, or tunnels along the deposit in any places that appear favorable until mica has been found in paying quantities. Only then should vertical shafts be sunk, either in the mica-bearing pegmatite or at one side of the vein, or long crosscut tunnels may be run from lower levels on a hillside. Few prospects give evidence on the surface that they will warrant extensive development or large outlay in mining equipment.

CLASSIFICATION OF MICA.

Mica is valuable in sheet form and as scrap suitable for grinding into a powder. For commercial sheet mica the individual pieces must be large enough to contain a rectangular area measuring at least 1½ by 2 inches, which must split easily and evenly and be nearly free from "cracks," "rulings," "markings," and all fracture lines and reasonably free from inclusions or specks of foreign mineral matter. The size stated is the smallest rectangular size that is salable in the form of uncut sheet; the irregularly bounded rough-trimmed mica sheet must be nearly twice as large to yield this size—in other words, a sheet that would yield a suitable rectangle 1½ by 2 inches and would be classed as "1½ by 2 inches" would have to measure nearly 3 by 4 inches.

Splittings are the thin films or flakes of mica that are split from the smaller sheet or waste material. They are about one-thousandth of an inch thick and are irregular in shape.

Material suitable as scrap mica for grinding must be free from all foreign matter, especially gritty material such as quartz and feldspar.

The system of classification of mica, by sizes, is different in the United States, Canada, and India. The United States classification is as follows (figures represent inches): Punch, circle, 1½ by 2, 2 by 2, 2 by 3, 3 by 4, 3 by 5, 4 by 6, 6 by 6, 6 by 8, 8 by 10, and larger. For punch mica the uncut sheet must be of sufficient size to yield a circle 1½ inches in diameter if stained and 1¼ inches if clear; circle mica should yield a disk nearly 2 inches in diameter.

Canadian or "amber" mica is also classified on the basis of the size of the rectangle obtainable, but the sizes differ from those used for the United States mica. The sizes used for Canadian mica, in inches, are 1 by 1, 1 by 2, 1 by 3, 2 by 3, 2 by 4, 3 by 5, 4 by 6, and 5 by 8.

The Indian classification is not based on the size of the rectangle obtainable but on the area of usable mica in the sheet. The following table shows the Indian system of grading, with the approximate corresponding sizes used in the United States classification:

Grading of Indian mica.

Grade.	Area of usable mica (in square inches), based on rectangular sizes.	Sizes of rectangles that can be cut (in inches).				Approximate corresponding sizes in United States classification (in inches).
		Width.		Length.		
		Minimum.	Maximum.	Minimum.	Maximum.	
6	Less than 3					Punch.
5	3 to 5⅞	1	2	2	2½	2 by 2.
4	6 to 9⅞	1½	2½	2½	3	2 by 3. / 3 by 3.
3	10 to 14⅞	1½	3	3	4½	3 by 4.
2	15 to 23⅞	1½	3½	4½	6	3 by 5.
1	24 to 35⅞	3	5	5	7	4 by 6.
A–1	36 to 47⅞	4	6	7	9	5 by 8.
Special	48 to 59⅞					6 by 8.
Extra special	60 to 71⅞					8 by 8.
Extra extra special	72 and more					8 by 10.

PRICES.

Value of domestic mica sold in the United States, 1918–1922.[a]

Year.	Total value.	Average value per short ton of all mica mined.	Average value per pound of sheet mica.
1918	$764,940	$246	$0.45
1919	541,651	134	.31
1920	713,989	109	.32
1921	175,362	59	.16
1922	308,346	43	.18

[a] Figures for 1918–19 represent average value of cut and uncut mica as reported by producers. Figures for 1920, 1921, and 1922 represent the average value in terms of uncut sheet mica only.

The following table is based in part on statements received from the producers and purchasers:

Average prices per pound paid in the South for rough-trimmed sheet mica of good quality split and sorted to cut the sizes indicated, 1919–1922.

Size (in inches).	1919	1920	1921	1922
Punch	$0.08	$0.10	$0.06	$0.06
1½ by 2	.55	.51	.35	.15
2 by 2	.95	.84	.55	.35
2 by 3	1.35	1.25	1.00	.75
3 by 3	1.85	2.04	1.40	1.35
3 by 4	2.15	2.37	2.00	1.75
3 by 5	2.55	2.95	2.50	(b)
4 by 6	3.50	3.85	3.00	2.75
6 by 6	(a)	4.00	3.50	(b)
6 by 8		5.00	5.00	3.70
8 by 10		7.00	(b)	(b)

[a] Prices exceedingly variable. [b] No information available.

USES.

As an insulating material in electrical apparatus and machinery sheet mica is used extensively. In fact, its most important use is in the electrical industry, where a noninflammable, resistant insulating material is necessary. Nearly every piece of apparatus and machinery utilizing electricity must have mica for insulation. In its resistance to puncture, infusibility, and imperviousness to moisture mica is an ideal insulator, and in addition it has physical properties—cleavage, transparency, toughness, hardness, elasticity, flexibility, and resonance—which are not found combined in any other substance. It is therefore serviceable for a variety of purposes, such as an electric insulating material in condensers for magnetos for the engines of automobiles, trucks, and airplanes; in condensers for radio-transmission apparatus; and in spark plugs for automobiles, trucks, and airplanes. Condenser mica must be clear, must split easily and smoothly into films as thin as one-thousandth of an inch, and must be free from cracks, holes, foreign substances, stains, spots, and smoke, and the sheets must be plane and smooth, free from waves, wrinkles, reeves, rulings, or knots.

Sheet mica and splittings are used as insulating material in the form of sheets, washers, and tubes in dynamos and in numerous electric fittings and appliances, such as electric heating devices, electric-light sockets, spark plugs, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, partly made of or covered with mica, find varied uses in electric apparatus. Sheet mica is used for glazing in the fronts of stoves, in furnace sightholes, for screens in front of highly heated material, for optical lanterns as a retarder of heat waves, and for making lamp chimneys and lamp shades.

As an insulator between the copper segments of the commutators for direct-current dynamos and motors phlogopite or "amber" mica is said to be preferred, as muscovite or "white" mica, being harder, does not wear down evenly with the copper, leaving a ridge above the copper bar that would cause sparking and irregular running. For all other insulation, however, the domestic muscovite is satisfactory.

Phonograph or diaphragm mica must be of a very high grade, for it must be clear and transparent and must also be flat.

Mica for lamp chimneys and canopies must be clear and must split easily and be very flexible. Very little domestic mica can be used for this purpose. Indian and Brazilian mica are used instead.

For stove fronts a nearly clear mica, hard and rigid, is most desirable, and much of the North Carolina mica, especially the greenish, is well adapted for this use.

Sheet mica of an inferior grade and splittings (mostly in the form of built-up mica board) are also extensively used for general electric insulation. Muscovite and phlogopite mica are both suitable for building into mica board. This material is prepared by splitting the mica into thin sheets, systematically placing them together with shellac, and then subjecting the whole to pressure. In this way large composite sheets are made, which are as suitable as single sheets of mica for some insulating purposes. The mica boards manufactured by different concerns are known by special trade names, such as "micanite," "micasbeston," and "micabond."

Most of the mica splittings produced are consumed in the manufacture of built-up mica board, but some splittings are used as such in making mica tubes for spark-plug cores and other insulating uses, wrapping for wire coils, and insulating tape.

Scrap mica, or mica that can not be utilized as sheet or splittings, is ground and sold in powdered form. Ground mica, usually coarsely ground, is used in patent roofing compositions, and for this purpose biotite or black mica is also suitable. The mica serves the purpose of keeping the material from sticking when rolled for shipping or storage. Ground mica is also used for decoration, chiefly in wall paper, fancy paint, ornamental tile, and concrete facings; as a lubricant; in annealing steel; and as an absorbent for nitroglycerin. Its heat-resisting qualities render it useful in railroad car-axle packings, in pipe and boiler coverings, in fireproof paints, and in rubber tires. Nearly all the mica ground in the United States is obtained from the mining and manufacturing of sheet mica, being the waste obtained in mining and the waste and trimmings resulting from the cutting of the sheet mica.

The following table has been compiled from reports received from companies consuming mica splittings:

Mica splittings consumed in the United States, 1920–1922, in short tons.

Origin.	1920	1921	1922
India	1,077	533	1,141
Canada	506	108	316
United States	33	13	11
South America	1	5	3
	1,617	659	1,471

WORLD'S PRODUCTION.

World's production of mica, 1913–1922, in metric tons.

Country.[a]	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
North America:										
United States (1)	5,599	3,636	3,843	4,414	3,690	2,825	3,657	5,956	2,674	6,514
Canada (2)	1,002	540	378	1,096	1,058	678	2,498	1,999	637	3,214
South America:										
Argentina (3)	6	½	.....	6	63	172	52	65	(b)	(b)
Brazil (4)	10	18	51	54	96	162	154	68	46	67
Europe:										
Norway (exports) (5)	(b)	33	21	24	39	66	96	31	2	(b)
Rumania (fiscal years) (6)	.....	.....	.....	.....	.....	.....	72	135	.....	.....
Spain (7)	.....	.....	.....	.....	.....	8	7	5	2	(b)
Asia:										
Ceylon (exports) (8)	.....	.....	.....	.....	.....	6	8	13	5	1
India (9)	2,325	2,058	1,379	2,205	2,078	2,778	2,326	2,385	1,650	(b)
Africa:										
Madagascar (10)	6	3	1	3	¼	4	19	49	141	92
Nyassaland (11)	9	5	4	1	.....	4	(b)	(b)	(b)	(b)
Rhodesia (12)	.....	.....	.....	.....	.....	.....	5	89	77	60
Tanganyika (11) (formerly German East Africa)	111	46	(b)	(b)	(b)	17	131	(b)	(b)	(b)
Union of South Africa, Transvaal (13)	(b)	(b)	2	12	4	5	3	1	1	3
Australia (14)	.....	4	3	1	38	.....	2	4½	(b)	(b)

[a] Source of data:
1, U. S. Geol. Survey.
2, 1913–1920, Canada Dept. Mines, Mines Branch; 1921–22, Dominion Bureau of Statistics.
3, Estadística minera.
4, Commercio exterior do Brasil.
5, Norges Handel.
6, Statistique minière de la Roumanie.
7, Estadística minera de España.
8, 1913–1918, Imperial Mineral Resources Bureau; 1919–1921, official figures furnished by American consul, Colombo, Ceylon; 1922, Bulletin des mines de Madagascar.
9, Records Geol. Survey of India.
10, 1913–1921, Rapport Service des mines, Madagascar; 1922, Bulletin des mines de Madagascar.
11, Imperial Mineral Resources Bureau.
12, Rept. Secretary for Mines, southern Rhodesia.
13, Secretary of Mines and Industries, Union of South Africa, Ann. Repts.
14, 1914–1916, Western Australia Mines Dept. Rept. (quantities for 1915 and 1916 estimated); 1917, Review of mining operations, Dept. Mines, South Australia; 1919 and 1920, same as for 1914–1916 and Dept. Mines, Northern Territory.
[b] Figures not available.

The sheet mica from the United States, as reported, is practically all uncut sheet. That from India is uncut sheet [1] and splittings. The Canadian mica is uncut sheet and splittings; the proportion of splittings to sheet is not known but is estimated to be much greater than that for India. For the other countries the mica reported is essentially trimmed sheet.

[1] Although the Madras square-trimmed mica is termed "cut mica" in import schedules, in reality it is uncut trimmed mica.

World's production of sheet mica, 1914–1922, in metric tons.

Year.	United States.	India.	Canada.[a]	Other countries.[b]	Total.	Percentage of total in United States.
1914	253	2,058	270	109	2,690	9
1915	251	1,379	189	82	1,901	13
1916	393	2,205	548	101	3,247	12
1917	579	2,078	529	240	3,426	17
1918	746	2,778	339	444	4,307	17
1919	701	2,326	1,249	519	4,825	15
1920	764	2,385	1,000	460	4,609	17
1921	337	1,650	319	274	(c)	(c)
1922	489	(c)	1,607	223	(c)	(c)

[a] Estimated as one-half of the total reported production of mica in Canada.
[b] The total reported production of mica for the other countries incomplete, as no figures of production are available for some of the countries.
[c] Figures not yet available.

IMPORTS AND EXPORTS.[2]

The imports of uncut sheet mica in 1922 were 385,653 pounds, valued at $359,793. Imports of mica were received from 18 countries.

Mica imported for consumption in the United States, 1919–1922.

Kind.	1919		1920		1921		1922	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Unmanufactured	[a]723,713	[a]$726,532	[a]1,298,537	[a]$1,177,943	[a]328,443	[a]$331,219	[a]385,653	[a]$359,793
Cut and split		[b]762,228		[b]2,011,434		[b]758,521		[c]555,243
Ground	62	9			134,650	2,166	313,745	4,514
Cut mica (dimension sheets)							[d]42,579	[d]18,372
Splittings							[d]1,063,306	[d]371,801
Built-up mica boards, cups, tubes, and mica plates	(e)	(e)	(e)	(e)	(e)	(e)	[d]1,807	[d]2,860
Washers							[d]2,562	[d]675
Other manufactures							[d]7,842	[d]17,361
		1,488,769		3,189,377		1,091,906		1,330,622

[a] Essentially uncut trimmed sheets.
[b] Includes the Madras square-shaped uncut sheets.
[c] January to September 21.
[d] September 22–December 31.
[e] Not separately classified prior to new tariff, Sept. 22, 1922.

The import duty on mica as fixed by the tariff act of September 22, 1922, paragraph 208, is as follows:

Mica, unmanufactured, valued at not above 15 cents per pound, 4 cents per pound, valued above 15 cents per pound, 25 per centum ad valorem; mica, cut or trimmed; and mica splittings, 30 per centum ad valorem; mica plates, and built-up mica, and all manufactures of mica or of which mica is the component material of chief value, 40 per centum ad valorem; ground mica, 20 per centum ad valorem.

Mica was exported to 41 countries in 1922, but about 78 per cent of the total quantity, which was 1,134,397 pounds, went to England, Canada, and France, in the order named. The total value of the mica exported ($129,186) was less than in 1920 and 1921 but greater than in 1916, 1917, 1918, and 1919.

[2] The statistical information on imports and exports has been compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

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SLATE.

By G. F. Loughlin and A. T. Coons.

GENERAL CONDITIONS.

The year 1922 was one of substantial recovery for slate and other structural materials from the dull period that had existed during and since the war. The slate industry benefited further by the vigorous campaign of the new National Slate Association to improve methods of producing, handling, and marketing slate and thus to induce more general consideration of its uses. Net sales from quarry companies in 1922 amounted to 607,680 short tons, valued at $9,176,784, an increase of 48 per cent in quantity and 25 per cent in value. This was not an abnormal increase, to judge from the activity in the building trades during the last part of 1922. According to the reports of the producers the demand for roofing slate and structural slate was very slow from January until June, after which there was a decided improvement. The large demand at the end of 1922 indicated very good prospects for 1923. The output of roofing slate increased 38 per cent over that of 1921, and the number of squares sold was the largest since 1917 but 67 per cent less than in 1902, the year of largest recorded production. However, the average value per square in 1922—$8.49—was nearly two and one-half times more than in 1902—$3.45. Structural and sanitary slate increased 25 per cent in quantity, but the production—2,131,800 square feet—did not equal that of 1920. Slate granules and slate flour increased about 64 per cent. Slate for electrical purposes increased 16 per cent, and that for blackboards and bulletin boards increased about 12 per cent. The production of slate for school slates was 23 per cent less than in 1921 and 36 per cent less than in 1920. The quantity of slate sold for grave vaults and covers and for billiard-table tops decreased 28 and 17 per cent, respectively.

There was a decrease in the average value of all the slate products except blackboards and bulletin boards and grave vaults and covers, which remained the same as for 1921. Lower average prices were reported by many operators during the year, some reported no changes, and reports of others showed that there was a tendency toward higher prices at the end of the year. Wages remained unchanged in some of the quarries, but increases of 5 to 20 per cent were reported by other operators. Common labor was reported as scarce. High freight rates, railroad strikes, high cost of coal, and embargo on shipments were among the difficulties with which the quarrymen had to contend. There were only a few strikes in the slate quarries; these were mostly in Pennsylvania and of short duration. The number of quarry companies reporting operations in 1922 was 104—2 less than in 1921. Several small operators in New York were

reported as idle in 1922, and reports were received from small operators in Vermont who opened their quarries during 1922. In these two States some quarries are worked intermittently, on a small scale, and the product is hauled to slate piles of other companies for marketing. In Pennsylvania companies that had been idle for several years resumed operations, and others that were active in 1921 suspended operations. As slate from some small producers passes into the hands of larger companies before reaching the market, care has to be taken to avoid duplication in compiling figures of production. The figures given in this report are compiled from reports of producers. Reports furnished from time to time by dealers and agents are used only to check producers' reports or to supplement them where reports of production are incomplete. The activities of slate associations in Pennsylvania and Vermont and of the newly organized National Slate Association, formed in 1922, have been continued and have had beneficial results through advertising and cooperation of different branches of the slate industry. The work of standardizing the sizes of slate required for the many different uses of this product has been carried on, and tentative specifications have been prepared regarding the slate required for different classes of work.

A report by Bowles [1] on the technical problems of slate quarrying, with special attention to better quarry methods and prevention of waste, up to now one of the chief problems of the slate producer, as well as suggestions for the utilization of the waste itself, may be obtained on application to the Bureau of Mines. The installation of new machinery, the introduction of electrical equipment and change to higher-powered machinery, and the expansion of some quarries and the development of new ones were reported by operators. An effort to obtain more efficient labor in the future was introduced at one of the Pennsylvania quarries, where a school for the instruction of boys and young men in the different branches of the slate industry and the handling of modern machinery has been established for the vacation period. It is stated that other companies have also started to train men for this trade in much the same manner. Much of the skilled labor that left the slate quarries for the war did not return, and the need for more competent help is severely felt. The localization of the principal slate quarries in the northeastern section of the United States renders the problem of transportation serious if it is desired to ship slate outside of a certain territory. Freight rates on slate are very high, and unless steady shipments of sufficient bulk can be guaranteed the carriers are reluctant to give rates that make it possible for the slate companies to ship slate any great distance in competition with cheaper but less durable materials. In July, 1922, lower freight rates were granted to the Vermont shippers, and their increase in production was attributed to this concession.

PRODUCTION.

The following tables show sales of slate by uses. Slate for blackboards, bulletin boards, and school slates is herein included under "Mill stock," leaving only granules, "flour," and a small quantity of slate sold for flagging, tombstones, and unspecified uses under "Other uses."

[1] Bowles, Oliver, The technology of slate: Bur. Mines Bull. 218, 1922.

In approximating the tonnage for the different slate products given in the following table a specific gravity of 2.75 has been used as the basis of calculation, and a thickness corresponding to an average for each product. The total quantity and value given for each use are the totals of the reports of the quarrymen (not the selling agents), and the value f. o. b. quarry or nearest point of shipment is given. It has been suggested that some of the mill stock finds its ultimate use for purposes other than reported by the quarrymen, but the Survey has no means of verifying this suggestion.

Slate sold in the United States, 1918–1922, by uses.

Year.	Roofing slate.			Mill stock.			Other uses.[b]	Total.
	Squares (100 sq. ft.).	Value.[a]		Square feet.	Value.[a]			
		Total.	Average.		Total.	Average.		
1918	379,817	$2,219,131	$5.84	7,204,000	$1,853,603	$0.26	$768,386	$4,841,120
1919	454,337	3,085,957	6.79	7,466,000	1,782,793	.24	1,161,898	6,030,648
1920	396,230	3,524,658	8.90	9,910,000	3,147,281	.32	2,054,503	8,726,442
1921	348,085	3,197,745	9.19	8,970,000	2,719,723	.30	1,404,538	7,322,006
1922	479,243	4,069,761	8.49	9,276,800	2,899,195	.31	2,207,828	9,176,784
Percentage of increase or decrease, 1922.	+37.7	+27.3	−7.6	+3.4	+6.6	+3.3	57.2	+25.3

[a] F. o. b. at point of shipment. [b] Chiefly slate granules.

Roofing slate, mill stock,[a] and slate granules sold in the United States in 1921 and 1922, by uses.

Use.	1921			1922			Percentage of increase or decrease.	
	Quantity.	Value.[b]		Quantity.	Value.[b]			
		Total.	Average.		Total.	Average.	Quantity.	Value.
Roofing.....squares	348,085	$3,197,745	$9.19	479,243	$4,069,761	$8.49	+37.7	+27.3
Approximate equivalent in short tons	117,500			161,700				
Electrical.....square feet	1,173,653	927,951	.79	1,363,300	996,322	.73	+16.2	+7.4
Approximate equivalent in short tons	8,400			9,700				
Structural and sanitary, square feet	1,706,321	642,532	.38	2,131,800	750,653	.35	+24.9	+16.8
Approximate equivalent in short tons	12,300			15,300				
Grave vaults and covers, square feet	552,592	121,967	.22	400,100	87,763	.22	−27.6	−28.0
Approximate equivalent in short tons	8,000			5,700				
Blackboards and bulletin boards.....square feet	3,154,201	791,241	.25	3,518,700	880,985	.25	+11.6	+11.3
Approximate equivalent in short tons	22,600			25,100				
Billiard-table tops.square feet	462,920	179,862	.39	383,900	141,445	.37	−17.1	−21.4
Approximate equivalent in short tons	3,300			2,700				
School slates.....pieces	3,591,376	56,170	[c]15.64	2,766,600	42,027	[c]15.19	−23.0	−25.2
Approximate equivalent in square feet	1,921,000			1,479,000				
Approximate equivalent in short tons	2,500			2,000				
Granules.....short tons	231,770	1,397,886	6.03	379,980	2,177,061	5.73	+63.9	+55.7
Other,[d] short tons (estimated)	5,130	6,652		5,500	30,767			
Total (quantities approximate, in short tons)	411,500	7,322,006		607,680	9,176,784		+47.7	+25.3

[a] In 1921 the mill stock sold, including school slates, was approximately 8,970,000 square feet, valued at $2,719,723; in 1922 it was approximately 9,277,000 square feet, valued at $2,899,195.
[b] F. o. b. at point of shipment.
[c] Average value per thousand pieces.
[d] Includes small quantity of slate sold for flagging (117,754 square feet, valued at $16,906, in 1922), tombstones, and other uses not specified.

Slate sold in the United States in 1922, by States and uses.

State.	Operators.	Roofing slate.			Structural and sanitary.		Electrical.		Other uses.[a]	Total.
		Squares (100 square feet).	Value.		Square feet.	Value.	Square feet.	Value.		
			Total.	Average.						
Georgia	1	.....	.....	.....	.....	.....	.....	.....	(b)	(b)
Maine	4	6,489	$88,702	$13.67	10,290	$10,858	407,550	$361,595	$3,558	$464,713
Maryland	2	(b)	(b)	9.78	(b)	(b)	.....	.....	(b)	(b)
New Jersey	1	(b)	(b)	8.72	.....	.....	.....	.....	.....	(b)
New York	9	1,215	22,537	18.55	(b)	(b)	.....	.....	620,060	642,972
Pennsylvania	46	283,365	2,076,585	7.33	2,022,210	676,954	422,310	231,274	1,339,481	4,324,294
Tennessee	1	.....	.....	.....	.....	.....	.....	.....	(b)	(b)
Vermont	35	149,912	1,498,120	9.99	96,790	62,131	533,440	403,453	944,154	2,907,858
Virginia	5	30,902	312,652	10.12	.....	.....	.....	.....	(b)	c 312,652
Undistributed	.....	d 7,360	d 71,165	9.67	d 2,510	d 710	.....	.....	d 452,795	d e 524,295
	104	479,243	4,069,761	8.49	2,131,800	750,653	1,363,300	996,322	3,360,048	9,176,784
Total, 1921	106	348,085	3,197,745	9.19	1,706,321	642,532	1,173,653	927,951	2,553,778	7,322,006

[a] For details see table of sales on page 167.
[b] Included under "Undistributed."
[c] Exclusive of value of granules, which is included under "Undistributed."
[d] Includes output of States entered as "(b)" above.
[e] Includes also value of granules for Virginia.

IMPORTS AND EXPORTS.[1]

Value of slate imported for consumption in the United States, 1917–1922.

1917	$1,024	1920	$4,512
1918	321	1921	2,923
1919	691	1922	2,753

Roofing slate exported from the United States, 1921 and 1922, by countries.

Country.	1921	1922		Country.	1921	1922	
		Number of squares.	Value.			Number of squares.	Value.
Canada	$74,546	8,134	$74,031	British Guiana	.....	200	$1,388
Mexico	2,029	30	128	Colombia	.....	12	116
Honduras	4	.....	.....	Venezuela	$145	.....	.....
Nicaragua	16	.....	.....	England	3,575	402	3,041
West Indies:				Ireland	11,887	996	9,212
Bermuda	.....	171	1,482	Denmark	.....	100	700
Cuba	.....	261	2,717	Australia	39	124	1,221
Jamaica	100	.....	.....	British South Africa	3,777	.....	.....
Trinidad and Tobago	332	126	1,388	China	1,400	.....	.....
Virgin Islands of the United States	80	.....	.....		101,630	11,040	97,811
Other British West Indies	.....	484	2,387				
Panama	3,700	.....	.....				

The following figures for exports of slate other than roofing were collected by the United States Geological Survey from shippers of the products named:

[1] The figures of imports and exports were compiled by J. A. Dorsey, of the United States Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Slate other than roofing exported from the United States in 1922, by destination.

Destination.	Electrical.		Billiard tables.		School slates.		Other.[a]		Total.
	Square feet.	Value.	Square feet.	Value.	Cases.[b]	Value.	Square feet.	Value.	
Canada	13,859	$12,086	63,753	$27,940	3,280	$35,168	105,096	$32,490	$107,684
Mexico	2,305	2,026	.....	.....	934	8,460	.....	.....	10,486
Central America	460	405	172	60	.....	.....	.....	.....	465
West Indies	3,365	2,952	2,396	897	2,602	17,549	1,516	1,134	22,532
South America	4,880	4,294	2,839	1,000	1,780	20,719	.....	.....	26,013
Europe	2,740	2,411	.....	.....	2,114	20,083	.....	.....	22,494
Africa	400	352	.....	.....	2,752	31,925	.....	.....	32,277
Oceania	7,315	6,436	.....	.....	3,545	41,222	.....	.....	47,658
Asia	11,895	10,465	.....	.....	2,800	19,836	.....	.....	30,301
	47,219	41,427	69,160	29,897	19,807	194,962	106,612	33,624	299,910

[a] All structural except 104,293 square feet of blackboards, valued at $32,217, exported to Canada.
[b] Cases weigh from 130 to 165 pounds each; average is 135 pounds.

REVIEW BY DISTRICTS.

The active slate-producing districts of the United States are the Monson district of Maine; the New York-Vermont district, including Washington County, N. Y., and Rutland County, Vt.; the Lehigh district, including Lehigh and Northampton counties, Pa., and Sussex County, N. J.; the Peachbottom district, including Lancaster and York counties, Pa., and Harford County, Md.; and the Buckingham County (Arvonia) and Albemarle County districts of Virginia. These districts produce roofing slate and mill stock, and some of them produce also roofing granules and slate flour. Roofing granules and flour are also produced in Georgia and Tennessee.

The operators in the different districts in 1922 are given below, with brief statements regarding prospective operations in other locations.

MAINE DISTRICT.

The greater part of the slate quarried in Maine is used for electrical purposes. Roofing slate is a much smaller part of the product, and small quantities of slate are sold annually for tombstones and flagging. In 1922 waste slate was crushed for granules from the dump of the old State of Maine quarry, at North Blanchard. The slate of this State is dark "blue-black" or "black" in color and is all in Piscataquis County, near Monson.

The operators in 1922 were as follows:

General Slate Co., 148 State Street, Boston, Mass.; roofing.
Monson Maine Slate Co., 112 Water Street, Boston, Mass.; electrical, roofing, etc.
Portland Monson Slate Co., Portland, Maine; electrical and roofing.
Monson Slate Products Co., 10 Milk Street, Boston, Mass.; roofing granules.

NEW YORK-VERMONT DISTRICT.

The slate quarried in New York is sold chiefly in the form of roofing slate and slate granules and flour. The only red slate quarried in the United States at present is obtained in New York, and

for that reason the average price of the roofing slate of this State is unusually high. The following firms operated in 1922:

Advance Industrial Supply Co., 111 West Washington Boulevard, Chicago, Ill.; quarry at Granville, N. Y.; red granules.
Old English Slate Quarries, 10 Milk Street, Boston, Mass.; Empire quarry at Granville, N. Y.; variegated slate for roofing, structural work, and flagging.
J. B. Preston & Co., 258 Broadway, New York City; Williams and Conner mills at Granville, N. Y.; red and black granules.
Standard Slate Products Co., Granville, N. Y.; red granules.
Staso Milling Co., 111 North Market Street, Chicago, Ill.; quarry at Hampton, N. Y.; red granules and flour.
Kehoe & Lewis, West Pawlet, Vt.; quarry at Hebron, N. Y.; red roofing slate.
John J. McDonough, West Pawlet, Vt.; quarry at Hebron, N. Y.; "colonial gray" roofing slate.
Laurel Slate Co., Bangor, Pa.; quarry at Middle Granville, N. Y.; red roofing slate.
Sheldon Slate Products Co., Middle Granville, N. Y.; Eagle quarry; red roofing slate, red granules and flour.

The slate quarries of New York are all in Washington County and adjoin the quarries in Rutland County, Vt., so closely that it is difficult to determine from the reports of some of the smaller quarries to which State they should be credited.

Vermont ranks next to Pennsylvania in value of slate production. However, on account of the large quantity of slate granules shipped from Vermont the total tonnage marketed in 1922 was more than that from Pennsylvania. Slate occurs in Vermont in varying shades of green, purple, gray, mottled colors, and black, which renders it of unusual value to architects seeking artistic and attractive color schemes for roofs. Besides roofing slate a large quantity of the Vermont slate is used for electrical purposes and smaller amounts for structural use and billiard tables. The Vermont slate is also crushed for granules and flour. The productive deposits are in Rutland County, adjoining the quarries in Washington County, N. Y.

The producing firms reporting to the Geological Survey in 1922 are as follows:

P. F. Hinchey & Co., Hydeville, Vt.; quarry at Castleton; electrical use.
John Jones Slate Co., Castleton, Vt.; electrical use; purple.
Staso Milling Co., 111 North Market Street, Chicago, Ill.; quarry at Castleton; granules and flour; green.
Clark-Flanagan (Inc.), Fairhaven, Vt.; roofing and electrical use.
Donnelly & Pincus, Poultney, Vt.; quarry at Fairhaven; roofing; unfading variegated green and purple.
Durick, Keenan & Co. (Inc.), Fairhaven, Vt.; electrical use and billiard tables; purple.
Eureka Slate Quarries, Fairhaven, Vt.; roofing; unfading green, mottled, variegated.
Fairhaven Marble & Marbleized Slate Co., Fairhaven, Vt.; roofing, flagging, billiard tables, structural and electrical use; unfading green, unfading mottled green, and purple.
General Slate Co., 148 State Street, Boston, Mass.; quarry at Fairhaven; roofing and flagging; green, unfading mottled green, and purple.
Mahar Bros. Slate Co., Fairhaven, Vt.; roofing, grave vaults and covers, flagging, and electrical use; unfading green and unfading mottled purple and green (roofing), mottled purple (electrical).
Old English Slate Quarries, 10 Milk Street, Boston, Mass.; quarry at Fairhaven; flagging, structural, and electrical use; unfading green, purple, variegated.
W. H. Pelkey Slate Co., Fairhaven, Vt.; roofing, grave vaults and covers, structural and electrical use; unfading green, mottled green and purple (roofing), unfading green, purple, mottled green and purple (other).

Hydeville Slate Works, Hydeville, Vt.; electrical use; green, purple, purple variegated.
Norton Bros., Granville, N. Y.; quarry at Pawlet; roofing; sea-green, unfading green, variegated purple.
O'Brien Bros. Slate Co., Granville, N. Y.; quarry at Pawlet; roofing; unfading green, unfading mottled green and purple.
Ondawa Slate Co., Granville, N. Y.; quarry at Pawlet; roofing; sea-green, black, purple.
Owen W. Owen's Sons (Inc.), Granville, N. Y.; quarry at Pawlet; roofing; sea-green.
Progressive Slate Co. (Inc.), Pawlet, Vt.; roofing; sea-green.
F. C. Sheldon Slate Co., Granville, N. Y.; quarries at Pawlet, South Pawlet, and West Poultney; roofing; sea-green, mottled purple.
Hugh G. Williams, Granville, N. Y.; quarry at Pawlet; roofing; sea-green.
Auld & Conger Co., 942 Prospect Street, Cleveland, Ohio; quarry at Poultney; roofing; sea-green, purple vein.
William Griffith Slate Co. (Inc.), Poultney, Vt.; roofing; sea-green, variegated purple, black.
New York Consolidated Slate Corporation, Poultney, Vt.; roofing; unfading green, unfading mottled green and purple.
Penryhn Slate Co. of Vermont, Poultney and West Castleton, Vt.; roofing, grave vaults and covers, structural and electrical use; unfading green (roofing), purple (electrical), green (structural).
Rising & Nelson Slate Co., Poultney and West Pawlet, Vt.; roofing; purple, green, gray, black, mottled.
Vermont Milling Products Corporation, Poultney, Vt.; granules; green.
Evergreen Slate Co. (Inc.), Granville, N. Y.; quarry at Wells; roofing, unfading green, unfading mottled green and purple.
Roberts Slate Co., Granville, N. Y.; quarry at Wells; roofing; sea-green.
Williams Bros., Middle Granville, N. Y.; quarry at Wells; roofing; sea-green.
Edwards Bros., West Pawlet, Vt.; roofing; sea-green.
Griffith J. Griffith, West Pawlet, Vt.; roofing; black.
Hughes & Edwards, West Pawlet, Vt.; roofing.
Jones Bros. Slate Co., West Pawlet, Vt.; roofing.
Jones & Roberts, West Pawlet, Vt.; roofing; black, sea-green.
Griffith T. Roberts Estate, West Pawlet, Vt.; roofing; sea-green, black.

MIDDLE ATLANTIC STATES.

The slate industry of New Jersey is limited to the operation of a small quarry near La Fayette, Sussex County, by the Lafayette Slate Quarry (Inc.). The product is a "blue-black" roofing slate and is sold locally. This quarry for both geologic and geographic reasons is included in the Lehigh district.

The other quarries of the Lehigh district are in Lehigh and Northampton counties, Pa., and have as a group been the leading producers of the country. Only one producer in the Pennsylvania part of the Peachbottom district was active in 1922.

The output of Pennsylvania slate quarries in 1922 represented nearly 50 per cent of the value and over 30 per cent of the quantity of all the slate quarried in the United States. It came from five counties. The product from Berks, Lancaster, and York counties was sold entirely as granules and flour. The product from Berks County is a slaty shale rather than a slate but is included with the slate on account of the similarity of its use with that of pulverized slate. The product from York County is at present crushed material from the dumps of an abandoned quarry, but at one time the quarries were operated for "Peachbottom" roofing slate. The product from Lehigh and Northampton counties is almost entirely roofing slate and mill stock. In 1922 a mill for the production of slate granules was operated at Pen Argyl.

The slate companies operating in Pennsylvania in 1922, with their chief products, are given below:

Berks County:
- Albany Co., Mertztown, Pa.; quarry at Albany; granules and flour; red.
- Greenwich Manufacturing Co., Lenhartsville, Pa.; granules and flour; red.

Lancaster County:
- Gorsuch Bros. (Inc.), Peachbottom, Pa.; granules and flour; blue-black.

Lehigh County:
- Blue Vein Slate Co., Slatington, Pa.; quarry at Slatedale; roofing, blackboards, school slates, structural and electrical use; black.
- Blumont Slate Co., Slatington, Pa., quarry at Slatedale; electrical use; black.
- Gap Slate Co. (William Foulk), Slatedale, Pa.; roofing, blackboards, bulletin boards, school slates, and structural use; blue.
- Highland Slate Co., Slatedale, Pa.; roofing, blackboards, and bulletin boards.
- Royal Blue Slate Co., Slatedale, Pa.; roofing, blackboards, bulletin boards, and electrical use.
- Thomas H. Shenton, Slatedale, Pa.; roofing, school slates, and electrical use; black.
- Thomas Slate Co. (Ltd.), Slatedale, Pa.; roofing school slates, and electrical use; dark blue and black.
- Blue Mountain Slate Manufacturing Co., Slatington, Pa.; roofing, structural and electrical use, blackboards and bulletin boards; dark blue.
- Brookside Slate Co., Slatington, Pa.; roofing, blackboards, bulletin boards, and structural use; blue.
- Cambridge Slate Co., Slatington, Pa.; roofing, blackboards, bulletin boards, and structural use; black.
- Slatington Slate Co., Slatington, Pa.; roofing, blackboards, bulletin boards, school slates, structural and electrical use; blue-black.

Northampton County:
- Bangor Central Slate Co., Bangor, Pa.; roofing; black.
- Bangor Quarry Co., 942 Prospect Avenue, Cleveland, Ohio; quarry at Bangor; roofing and structural use; black.
- Bangor Washington Slate Co., Bangor, Pa., roofing; blue-black.
- Columbia Bangor Slate Co., Bangor, Pa.; roofing; blue.
- North Bangor Slate Co., Bangor, Pa.; roofing, blackboards, bulletin boards, billiard tables, grave vaults and covers, school slates, structural and electrical use; blue-black.
- Slate Products Co. (Inc.), Bangor, Pa.; blackboards, grave vaults, structural and electrical use; blue-black.
- Woodley Slate Co., Bangor, Pa.; blackboards, billiard tables, bulletin boards, grave vaults and covers, structural and electrical use; black.
- Belfast Slate Co., Belfast, Pa.; roofing and flagging; black.
- Northampton Hard-Vein Slate Co., Easton, Pa.; quarry at Belfast; roofing and flagging; dark blue-gray.
- Theo. Whitesell Co. (Inc.), Easton, Pa.; quarry at Belfast; roofing; dark blue-gray.
- Genuine Washington Slate Co., Slatington, Pa.; quarry at Berlinsville; roofing, blackboards, bulletin boards, structural and electrical use; black.
- Roberts Bros., R. D. Walnutport; quarry at Berlinsville; roofing and school slates; gray.
- Chapman Slate Co., Myers Building, Bethlehem, Pa.; quarry at Chapman Quarries; roofing; black.
- Chapman Standard Slate Co., Stephen Girard Building, Philadelphia, Pa.; quarry at Chapman Quarries; roofing; black.
- East Bangor Consolidated Slate Co., East Bangor, Pa.; roofing, grave vaults and covers, billiard tables, structural use; blue-black.
- Albion Vein Slate Co., Bangor, Pa.; quarry at Pen Argyl; roofing; blue-black.
- Belmont Slate Co., Bangor, Pa.; quarry at Pen Argyl; roofing, grave vaults and covers, blackboards, bulletin boards, structural use; blue-black.
- Diamond Slate Co., Pen Argyl, Pa.; blackboards, bulletin boards, billiard tables, grave vaults and covers, structural and electrical use; gray-blue.
- Doney Slate Co. (Inc.), Pen Argyl, Pa.; roofing, blackboards, bulletin boards, structural and electrical use; blue.

Northampton County—Continued.

Jackson-Bangor Slate Co., Pen Argyl, Pa.; roofing, blackboards, bulletin boards, structural use; blue.

Keenan Structural Slate Co., Bangor, Pa.; quarry at Pen Argyl; roofing, blackboards, bulletin boards, grave and vault covers, structural and electrical use; blue-black.

Parsons Manufacturing Co., Pen Argyl, Pa.; granules and flour; blue-black.

Parsons Bros. Slate Co., Pen Argyl, Pa.; roofing, grave vaults and covers, blackboards, billiard tables, electrical use; blue-black.

Stephens-Jackson Co., Pen Argyl, Pa.; roofing, grave vaults and covers, blackboards, bulletin boards, structural and electrical use; blue-black.

D. Stoddard & Son, Bangor, Pa.; quarry at Pen Argyl; structural use, grave vaults and covers; blue-black.

Bangor Fidelity Slate Co., Bangor, Pa.; quarry at West Bangor; roofing, blackboards, bulletin boards, billiard tables, grave vaults and covers; structural and electrical use; black.

Albion Bangor Slate Co., Wind Gap, Pa.; roofing, billiard tables, structural and electrical use; blue.

Arvon Slate Co., Wind Gap, Pa.; roofing, blackboards, bulletin boards, billiard tables, structural use; black.

Colonial Slate Co., Bangor, Pa.; quarry at Wind Gap; roofing, blackboards, billiard tables, structural and electrical use; blue-black.

Phoenix Slate Co., Wind Gap, Pa.; roofing, blackboards, bulletin boards, billiard tables, structural use; black.

M. L. Tinsman & Co., Pen Argyl, Pa.; quarry at Wind Gap; roofing, blackboards, bulletin boards, billiard tables, grave vaults and covers, structural and electrical use; black.

York County:

Blue Mountain Stone Co., Hagerstown, Md.; quarry at Delta; granules; black.

Slate sold in Pennsylvania in 1922, by counties and uses.

	Operators.	Roofing slate.			Mill stock.			
		Squares (100 square feet).	Value.		Structural and sanitary.[a]		Electrical.	
			Total.	Average.	Square feet.	Value.	Square feet.	Value.
Berks, Lancaster, and York	4							
Lehigh	11	26,834	$188,422	$7.02	65,934	$19,942	242,223	$128,367
Northampton	31	256,531	1,888,163	7.36	2,342,786	741,993	180,087	102,907
Total, 1921	46	283,365	2,076,585	7.33	2,408,720	761,935	422,310	231,274
	47	202,605	1,565,109	7.72	2,189,080	720,462	337,186	216,271

	Operators.	Mill stock—Continued.				Other.[b]	Total.
		Blackboards and bulletin boards.		School slates.			
		Square feet.	Value.	Square feet.	Value.		
Berks, Lancaster, and York	4					$160,164	$160,164
Lehigh	11	518,436	$95,654	1,968,797	$30,105		462,490
Northampton	31	2,999,782	784,942	797,812	11,922	171,713	3,701,640
Total, 1921	46	3,518,218	880,596	2,766,609	42,027	331,877	4,324,294
	47	3,154,201	791,241	3,591,376	56,170	246,133	3,595,386

[a] Includes slate for grave covers and vaults.

[b] In 1921 includes 371,550 square feet of billiard-table material, valued at $142,205, and 15,680 short tons of granules and "flour," valued at $101,694; and in 1922, 328,845 square feet of billiard-table material, valued at $119,209, and 30,673 short tons of granules and "flour," valued at $196,915.

Only two quarries were in operation in the "Peachbottom" district near Cardiff, Harford County, Md., during 1922—those of the Peachbottom Slate Co. of Harford County (roofing slate) and the Peerless Slate Co. (roofing slate and mill stock), 903 Century Building, Pittsburgh, Pa.

SOUTHEASTERN STATES.

Virginia.—In 1922 slate was produced in Virginia at Esmont, Albemarle County, and Arvonia, Buckingham County. The production at Esmont was made by the Blue Ridge Slate Corporation, operating the Flint-Arrow quarry for blue-black granules. It is stated that this company will also manufacture roofing slate in 1923. All the slate produced in Buckingham County is sold for roofing and is quarried by the LeSueur Slate Co. and the Richmond Slate Co., at Ore Bank, and the Williams Slate Co. and Arvonia-Buckingham Slate Co., at Arvonia.

Tennessee.—The Tennessee Rock Products Co. (Inc.), Hagerstown, Md., is the only company producing slate in Tennessee. The property of this company is at Tellico Plains, Monroe County, and the entire product is ground and sold in the form of granules. The color of this slate is green.

Georgia.—The Flexatile quarry, near Cartersville, Bartow County, Ga., was operated in 1922 by the Richardson Co., Lockland, Ohio, for green slate granules and flour, used in the manufacture of patent roofings and fillers. This was the only slate quarry operated in the State.

Alabama.—A deposit of purple and green slate at Jemison, Chilton County, Ala., owned by J. P. Van Derveer, of Clanton, has been reported to the Geological Survey as in process of development, but no slate has yet been marketed. It is understood that the product is to be used for roofing granules.

CENTRAL STATES.

Minnesota.—An attempt was made in 1922 to reopen the old slate quarries near Cloquet, Carlton County, Minn., and the Minnesota Slate Co., Merchants Bank Building, St. Paul, was organized for the purpose. However, soon after work began the Great Northern Power Co. instituted proceedings to condemn land that included this property, and operations were discontinued pending the termination of these proceedings. The last report to the Geological Survey of production from these quarries was in 1901.

Arkansas.—There has been no development of the slate deposits of Arkansas for several years, and all the companies organized about 1900–1908 for the working of this slate have practically abandoned their projects. The deposits, which are near Slatington, Montgomery County, and Mena, Polk County, contain red, black, and green slate but are said to be at present too far from transportation to be operated successfully.

WESTERN STATES.

Arizona.—Deposits of slate near Phoenix, Maricopa County Ariz., have been operated for assessment requirements only by the Arizona Commercial Slate Co., represented by V. C. Hanney, and the

Phoenix Slate Co., represented by Shirley Christey, both of Phoenix. This slate is of bluish-gray color.

Utah.—In 1922 the Slate & Rock Products Co., Provo, Utah, took over the slate deposit near Provo, which was formerly worked on a small scale for green and purple crushed slate, but no slate from this deposit was marketed during the year.

Colorado.—W. D. Parry & Co., owners of the Green Placer slate claims at Marble, Gunnison County, Colo., have never operated these deposits except to cover assessment requirements.

California.—No slate was marketed from the quarries of California during 1922. The Losh quarry, at Placerville, Eldorado County, owned by Frank A. Losh, of San Francisco, was operated with a small force, and some roofing slate was made but was not put on the market. The Chadbourne quarries, near Placerville, have been taken over by The Eldorado Slate Products Co., Sacramento, and are being put into condition for operation. The quarries of the Sierra Slate Corporation and of the California-Bangor Slate Co., also near Placerville, were idle. The Pacific quarry, at Hornitos, Mariposa County, was leased by W. A. Hildreth, jr., of Stockton, during 1922, and development work was done with a view to marketing the product in 1923. The California slate is of dark bluish-gray color and so far has been used only for roofing slate.

SULPHUR AND PYRITES.

By H. A. C. Jenison and H. M. Meyer.

SULPHUR.

GENERAL CONDITIONS.

The notable feature of the sulphur industry in 1922 was the increase in sales.

An agreement between the American and Sicilian sulphur producers regulating the world's sulphur market was consummated early in the spring of 1923. The agreement, which applies only to unrefined sulphur, is to hold until September 30, 1926, and thereafter may be renewed. The prices will be regulated in relation to the demands for consumption, with an intention of gradually regaining the pre-war levels based on a gold standard, and will be increased by $1 a ton over those temporarily put into effect last October. North America will be supplied by the American producers, Italy by the Sicilian producers, and the remainder of the world proportionately by the two groups, with the provision that Sicilian producers may sell to any country a maximum of 65,000 tons for the manufacture of sulphuric acid. This agreement permits Sicily to export annually 210,000 tons, including 65,000 tons for sulphuric acid, a quantity largely in excess of Sicilian exports in recent years. A central bureau will be established in London to exchange information and statistics between the contracting parties to facilitate the execution of the agreement. The contracting parties are obliged to maintain the present status of the industry so far as the refining and grinding of sulphur is concerned, a provision which amounts to a guaranty of market for the Italian output of worked sulphur. Disagreements arising between the contracting parties will be submitted to a London board of arbitrators composed of a representative of each party and a third agreed upon by these two or in the event of failure to agree by the president of the chamber of commerce. The agreement may be terminated at any time prior to 1926 on not less than six months' notice, except during the sulphur-selling season.

The Texas Gulf Sulphur Co., as part of its contribution to the solution of the problem of finding a market for sulphur, has established a scientific-research department for the purpose of determining new uses for sulphur and increasing consumption.

DOMESTIC PRODUCTION.

In 1922 the sulphur output in the United States came from five mines, one each in Louisiana, Nevada, and Utah and two in Texas. A mine in Colorado that produced in 1921 temporarily suspended operations in 1922. More than 99.9 per cent of the output of sulphur was produced by the mines of the Texas Gulf Sulphur Co., at Big Hill, Matagorda, Tex.; the Freeport Sulphur Co., at Freeport, Brazoria County, Tex.; and the Union Sulphur Co., at Sulphur, Calca-

sieu Parish, La. These three companies have furnished more than 99.5 per cent of the sulphur produced since 1919, and prior to that time the Freeport Sulphur Co. and Union Sulphur Co. furnished 99 per cent. The Union Sulphur Co. was the first of these three companies to produce a notable quantity and prior to 1913 made practically the entire output of the country. The Freeport Sulphur Co. began operations in November, 1912, but it took some time to reach its present place in the industry.

The output of sulphur in the United States in 1922 was 1,830,942 long tons, as compared with 1,879,150 long tons in 1921, and except for that in 1921 was the highest ever recorded. The shipments were 1,343,624 tons, 41 per cent more than those in 1921 (954,344 tons) and second only to those of 1920 (1,517,625 tons). Although the estimated value of the shipments increased from $17,000,000 in 1921 to $22,000,000 in 1922, the average value per ton was less.

The large stocks previously accumulated by producers were materially increased during 1922.

Sulphur produced and shipped in the United States, 1917–1922.

Year.	Mined (long tons).	Shipped.	
		Long tons.	Approximate value.
1917	1,134,412	1,120,378	$23,987,000
1918	1,353,525	1,266,709	27,868,000
1919	1,190,575	678,257	10,252,000
1920	1,255,249	1,517,625	30,000,000
1921	1,879,150	954,344	17,000,000
1922	1,830,942	1,343,624	22,000,000

IMPORTS AND EXPORTS.[1]

Sulphur imported for consumption in the United States in 1922.

	Long tons.	Value.
Crude or brimstone (Jan. 1 to Sept. 21)	130	$4,259
Refined (Jan. 1 to Sept. 21)	1	50
Lac, or precipitated (Jan. 1 to Sept. 21)	10	3,365
Sublimed, or flowers of (Jan. 1 to Sept. 21)	118	4,875
Sulphur and sulphur ore (Sept. 22 to Dec. 31)	37	2,194
	296	14,743

The exports of sulphur or brimstone in 1922 were 199,902 long tons greater than those in 1921 and were the highest on record, surpassing the former record of 477,450 tons in 1920 by 8,214 tons.

Sulphur or brimstone exported from the United States, 1917–1922.

Year.	Long tons.	Value.	Year.	Long tons.	Value.
1917	152,736	$3,500,819	1920	477,450	$8,994,350
1918	131,092	3,626,638	1921	285,762	4,524,768
1919	224,712	6,325,552	1922	485,664	7,095,628

[1] Statistics of imports and exports have been compiled by J. A. Dorsey from records of the Bureau of Foreign and Domestic Commerce.

Although the customs districts from which crude sulphur was cleared in 1922 are distributed around the entire border of the country, practically all the sulphur exported was produced by the large mines in Texas and Louisiana.

Sulphur exported from the United States in 1922, by destination.

Destination.	Sulphur or brimstone.		Refined, sublimed, and flowers of.	
	Long tons.	Value.	Pounds.	Value.
Europe:				
Belgium	5,012	$80,192	.....	.....
Finland	12,650	191,950	.....	.....
France	93,168	1,294,868	25	$163
Germany	63,164	908,886	672,600	9,764
Netherlands	14,107	213,912	.....	.....
Norway	6,000	85,200	.....	.....
Spain	14,971	223,605	100	7
Sweden	41,325	589,784	.....	.....
England	38,063	554,365	3,708	609
Other Europe	3,814	60,738	2,000	209
	292,279	4,203,441	678,433	10,773
North America:				
Newfoundland and Labrador	2,000	32,000	2,190	75
Canada	107,974	1,681,587	990,250	24,194
Mexico	7,818	117,948	877,416	20,607
	117,792	1,831,535	1,869,856	44,876
Central America and the West Indies:				
Guatemala	15	784	105,715	3,397
Nicaragua	7	171	99,988	3,309
West Indies and Bermudas	34	1,315	71,292	1,848
Cuba	1,506	21,408	127,610	3,965
Other	74	3,031	157,073	4,872
	1,636	26,709	561,678	17,391
South America:				
Argentina	1,500	18,000	253,340	3,468
Brazil	1,782	38,322	104,201	2,873
Other	233	7,349	161,081	6,213
	3,515	63,671	518,622	12,554
Asia:				
Java and Madura	10	250	133,484	2,269
Other	3,431	60,685	99,596	2,011
	3,441	60,935	233,080	4,280
Oceania:				
Australia	48,825	664,511	1,164,520	19,901
New Zealand	5,625	71,962	132,934	3,798
Other	.....	.....	2,240	78
	54,450	736,473	1,299,694	23,777
Africa:				
British South Africa	8,551	112,864	383	55
Other	4,000	60,000	1,220	53
	12,551	172,864	1,603	108
	485,664	7,095,628	5,162,966	113,729

European countries, headed by France, Germany, Sweden, and England, received 60 per cent of the sulphur or brimstone exported from the United States. Canada received 22 per cent, which was the largest amount exported to any one country, and Australia received 10 per cent. Exports to Canada increased from 59,487 long tons in 1921 to 107,974 tons in 1922; to France, from 55,304 to 93,168 tons; to Germany,

from 23,049 to 63,164 tons; to Sweden, from 13,331 to 41,325 tons; and to England, from 14,897 to 38,068 tons. In 1922 Sweden took the place England held in 1921 as the third largest European importer of United States sulphur.

The distribution of exports of refined and sublimed sulphur and flowers of sulphur was more varied, only 13 per cent going to Europe, 19 per cent to Canada, 23 per cent to Australia, 17 per cent to Mexico, 11 per cent to Central America and the West Indies, and 10 per cent to South America. The average price of sulphur or brimstone exported was $14.61 a long ton, compared with $15.83 in 1921.

PYRITES.

DOMESTIC PRODUCTION.

The domestic production of pyrites increased 8 per cent in quantity but decreased 6 per cent in value in 1922. The lower cost of producing sulphur as compared with that of producing pyrites and the large quantity of sulphur available has caused the tremendous decrease in the production of pyrites, resulting in 1921 in the smallest output since 1897, when it was 143,000 tons.

The total production of pyrites in the United States in 1922 was 169,043 long tons, valued at $671,241. This was produced by 5 mines in 4 States, whereas in 1921 the output came from 14 mines in 8 States, and in 1920 from 25 mines in 10 States. In 1922 there were only two producers in California and one in Virginia, and figures for these States may not be disclosed. The one producer in New York, the Northern Ore Co., and the one producer in Wisconsin, the Connecting Link Mining Co., have both given permission to publish the quantity produced by them, 5,900 and 600 long tons, respectively.

California maintained first place in the production of pyrites in 1922, with Virginia in second place. The Stauffer Chemical Co., which operated a pyrites deposit in California in 1921, reported that its mine had been worked out and consequently closed.

The pyrites produced by the Northern Ore Co. is a by-product of zinc concentration. This company is erecting a pyrites-retreatment plant that will use powerful magnetic machines to remove the small amounts of zinc left in the pyrites from the original mill operations. These machines pull out the zinc blende. The pyrites is not roasted, so that it retains its value for its sulphur.

The total sulphur content of lump and fines produced in 1922 was equivalent to 79,362 long tons, compared with 67,124 tons in 1921. This would indicate an average content of 47 per cent, compared with an indicated average of 43 per cent in 1921.

Pyrites produced in the United States, 1917–1922.

Year.	Long tons.	Value.	Year.	Long tons.	Value.
1917	482,662	$2,593,035	1920	310,777	$1,596,961
1918	461,494	2,644,515	1921	157,118	711,432
1919	420,647	2,558,172	1922	169,043	671,241

The future of the domestic pyrites industry, except at a few places that are very favorably situated, is not promising. Domestic pyrites can not, under normal conditions, compete in markets on the Atlantic seaboard with domestic sulphur or with Spanish pyrites.

IMPORTS.

The imports of pyrites increased from 216,229 long tons in 1921 to 279,454 tons in 1922. The imports in 1921, however, were the smallest recorded since 1896. The continuous decrease in imports has been due to the same causes that have affected domestic production—mainly, large quantities of native sulphur made available more cheaply than pyrites could be.

Imports of sulphur ore as pyrites, containing more than 25 per cent of sulphur, in 1922, by countries and districts of entry.

Country.	Long tons.	Value.	District of entry.	Long tons.	Value.
Canada	66	$655	Buffalo	40	$528
			St. Lawrence	25	50
			Ohio	1	77
Cuba	1,000	6,500	North Carolina	1,000	6,500
France		3	San Francisco		3
Germany	9	25	Philadelphia	9	25
Italy	9,107	62,454	Philadelphia	9,107	62,454
Spain	269,272	1,129,463	New York	29,572	162,291
			Philadelphia	138,049	619,555
			Maryland	93,572	297,985
			South Carolina	2,000	7,029
			Virginia	6,079	42,603
Japan		1	San Francisco		1
	279,454	1,199,101		279,454	1,199,101

A comparison of the foregoing data with the similar data for 1921 shows that imports of pyrites from Canada decreased 6,934 long tons and those from Cuba 15,250 tons, that Bermuda dropped out entirely, and that imports from Italy increased 9,103 tons and those from Spain 77,757 tons. The imports from Spain represented 96 per cent of the total and had an average value of about $4.19 a ton, as compared with an average of $4.29 for the total.

SILICA.

By Frank J. Katz.[1]

INTRODUCTION.

Silica (SiO_2) occurs in deposits of commercial importance in many different forms, such as vein quartz, as a constituent of pegmatites, as sand, sandstone, quartzite, or flint, as tripoli, and as diatomaceous (infusorial) earth. In some forms, such as rose, smoky, and amethystine quartz, it has value as gems. This chapter deals with silica of all kinds except gem quartz, silica sand or sandstone used for making glass, and silica used in the form of sand, gravel, and crushed material for building, for concrete and mortar, for foundry and furnace work, and for cutting and grinding stone. Such material as is not here included is either gem material or sand, is commercially so designated, and is therefore considered in other chapters of Mineral Resources. Tripoli and diatomaceous earth are to a large extent consumed as abrasives and are considered in the chapter on abrasive materials.

USES.

Silica as considered in this chapter is used for many purposes, principally in the manufacture of pottery, paints, and scouring soaps, as a wood filler, as a polisher, and in metallurgical and chemical processes. In the pottery industry, where it is generally called flint, silica is used in the body of the ware to diminish shrinkage and is also used in glazes. Silica for use in pottery should contain less than 0.5 per cent of iron-bearing minerals. Manufacturers of paint use considerable quantities of very finely ground silica, which forms as much as one-third of the total pigment in some paints. For this purpose finely ground crystalline material is superior to fine sand in its natural state because of the angularity of the grains, which makes them adhere more firmly to the article painted and after wear affords a good surface for repainting. The same angularity makes artificially comminuted crystalline quartz superior to natural sand for use in wood fillers. For soaps and polishing powders ground material is preferred to natural sand on account of its whiteness and angularity. For all these purposes large quantities of pure quartz sand and sandstone are finely ground and yield a product fully equal to that obtained by grinding massive crystalline quartz.

Quartz crushed and graded to various sizes is used in making sandpaper and sand belts, as a scouring agent, for "frosting" glass with sand-blast apparatus, and for other purposes. Blocks of massive quartz and quartzite are used in the chemical industry as a filler for acid towers and as a flux in copper smelting. Ground quartz is also used in filters and in tooth powders and by dentists as a detergent.

[1] Statistics prepared by L. M. Beach.

The material known commercially in the United States as tripoli, which is the siliceous residue of decomposed limestone, also yields an excellent grade of pulverized silica, which is used for the same purpose as silica powder obtained from massive crystalline quartz and from sand and sandstone. Diatomaceous (infusorial) earth is also used to make polishing powder that is employed for similar uses to those for which quartz, sand, and tripoli powders are employed, but diatomaceous earth has somewhat different properties, and most of it finds different application, as insulating and filter material.

Sand and crystalline quartz have been used in making silicon and alloys of silicon with iron, copper, and other metals in the electric furnace. Quartz may be fused in the electric furnace to make chemical apparatus, such as tubes, crucibles, and dishes. The following notes on quartz glass have been supplied by Frank L. Hess:

The making of quartz glass received its impetus from several directions. Chemists needed glassware, especially in the form of tubes that were more resistant to chemical reagents and to heat than any glasses of more complex composition. Mercury arc lamps, now largely used for water sterilization, require a tube that will stand a temperature in the neighborhood of 600° C. The application of ultraviolet rays also demands clear glass rods and tubes, and chemical manufacturers need large tubing that is resistant to heat and to corrosion by hot gases and vapors. For some chemical work glasses do not need to be clear, but the glass used in mercury arc lamps must be transparent. Most quartz contains bubbles of air, water, carbon dioxide, or other substances which, on heating, become greatly enlarged, and when molten the quartz may appear satiny from the great number of bubbles, which were almost unnoticeable before. For those uses in which it is not necessary to have a transparent glass, a pure quartz sand furnishes a good raw material, but for transparent glass only the purest quartz in large pieces can be used, so that the difference in the price of glass free from bubbles and that containing only comparatively few bubbles may appear disproportionately large. Another reason for the greater cost of the transparent glass is the great loss through volatilization of melted quartz. A charge of 5 or 6 pounds of quartz is melted in less than 20 minutes in an electric furnace, but in that time it loses 20 per cent by volatilization. If the charge is sand or some other cheap grade of quartz, such a loss means little, but with a charge of high-grade Brazilian pebble the loss is more serious.

The first quartz glass was all formed by hand, and handwork is still used for crucibles, beakers, and similar ware. Tubing and rods, however, are now made mechanically of various sizes and lengths. An extremely clear glass is made by the General Electric Co. at Lynn, Mass., where Dr. E. R. Berry has conducted experiments for the last seven years and where a large quartz-glass plant was to be constructed during 1923. The quartz used for the glass is the best Brazilian pebble, carefully treated with acids so as to remove all traces of iron and other soluble materials. Dr. Berry has so far solved his problem that he is able to make mechanically tubes and rods of definite sizes.

One of the greatest inducements for the working out of mechanical methods of quartz-glass manufacture has been the difficulty in developing and handling skilled workmen in quartz glass. When heated

to the melting point quartz glass is so incandescent that the light it gives is too dazzling to allow the glass to be worked by direct vision, so that in general it is worked by men wearing dark spectacles, and between them and the work is a dark glass plate. Little of the work that is not incandescent can be seen through the spectacles, and as only small parts of the glass can be kept heated in the small oxy-acetylene flames used and it is necessary to examine the glass more closely at frequent intervals, the spectacles must be removed and the work allowed to cool. These difficulties make the work extremely trying and introduce complications in directing such labor.

In making tubes for mercury arc lamps it is necessary that the tubes be welded with glass that can be worked at lower temperatures, and this is accomplished by making a mixture of quartz and "pyrex" glass, which changes regularly from pure quartz to pure "pyrex." Quartz-glass tubing is now made in diameters reaching several inches and in complex coils, for the condensation of acids and other hot fumes.

In the mechanical making of clear-glass tubes and rods very heavy gas pressures are sometimes used, and the rods and tubes are extruded directly into water. The resistance of quartz glass to extreme changes in temperature is one of its most valuable qualities. Rods and tubes 26 feet long have been made by the General Electric Co., and the rods are so transparent that when a burning match is held at one end the light emerges at the other end apparently almost undiminished. Its remarkable transparency, its hardness, and its high index of refraction make quartz glass a very desirable material for lenses, and Dr. Berry hopes to be able to obtain it free enough from bubbles to make telescope lenses.

Quartz glass is useful in ultra-violet ray work because it is transparent to the rays, whereas ordinary glasses are opaque. This property of quartz glass has been utilized in making mercury arc lamps for the sterilization of water supplies and for the treatment of disease. Swimming pools in which it is not easy to change the water are equipped with one or more of the arc lamps, depending on the number of bathers and the size of the pool. The lamps are placed in a trough through which the water is constantly pumped. It is said that two lamps will thoroughly sterilize and keep sterile water in a pool in which several hundred persons are bathing. One pool on the East Side in New York in which two lamps were operated and in which the water was not changed during an entire season is said to have shown less live germs at the end of the time than the water contained when it was drawn from the city mains.

Ultra-violet rays are used in the treatment of wounds and diseases of the jaws and nasal passages. Two forms of apparatus have been used. In one form the rays were applied through a hollow cone of quartz glass having most of its surface covered with a metallic film, leaving only the point through which the rays passed. It is difficult to apply such an apparatus to the inside of the mouth, and therefore another form has been devised in which solid rods of transparent quartz glass are attached directly to a small water-cooled mercury arc that is easily held in the hand, and the rods are bent to suit the portion of the mouth to which the rays are to be applied. The rays will follow the rod, as a fluid follows a tube, and leave the rod at the end. Straight rods of various cross sections are used in the nasal passage. Remarkable results in the healing of indolent wounds and sores are said to have been obtained.

SALES.

The sales of quartz from pegmatite dikes, veins, and quartzite in 1922 showed a decrease of 5 per cent in quantity in comparison with 1921. The prices of crude quartz in 1922 ranged from $2 to $6.88 a ton and averaged $4.54. Prices of ground quartz ranged from $13.71 to $40.31 and averaged $14.05. Production was reported from California, Connecticut, Maryland, New York, Pennsylvania, and Wisconsin.

Silica sold for pottery, paints, fillers, polishers, abrasives, and other uses in the United States, 1920–1922.

Material.	1920		1921		1922	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Quartz (vein quartz, pegmatite, and quartzite)	68,190	$320,350	11,252	$84,957	10,653	$101,347
Sand and sandstone[a]	158,395	1,183,014	105,887	802,450	163,295	1,061,057
Tripoli (ground and otherwise prepared)	40,233	569,677	12,340	213,013	30,205	316,728
Diatomaceous earth	61,922	1,079,693	[b] 55,134	[b] 682,616	44,761	386,669
	328,740	3,152,734	184,613	1,783,036	248,914	1,865,801

[a] Includes only finely ground material. Figures probably incomplete.
[b] Partly estimated.

Quartz sold in the United States, 1918–1922.

Year.	Crude.		Ground.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1918	61,008	$121,888	10,732	$137,442	71,740	$259,330
1919	51,774	135,187	11,558	238,384	63,332	373,571
1920	59,423	142,397	8,767	177,953	68,190	320,350
1921	8,570	39,660	2,682	45,297	11,252	84,957
1922	5,085	23,093	5,568	78,254	10,653	101,347

IMPORTS.

The Bureau of Foreign and Domestic Commerce records imports of "flint, flints, and flint stones, unground," from several countries. These imports are partly flint pebbles for use in grinding mills and partly material for uses such as are listed in this report. The figures can not be accurately separated.

Value of pebbles and flint imported for consumption in the United States, 1917–1922.

1917	$197,156	1920	$338,630
1918	127,808	1921	116,157
1919	250,096	1922	145,805

SAND AND GRAVEL.

By L. M. Beach.

PRODUCTION.

Producers of sand and gravel in the United States reported to the Geological Survey sales in 1922 amounting to $64,617,664, as compared with $56,484,245 (revised figures) in 1921. The increase in quantity was 19 per cent and was made in spite of the fact that cars were not always available for shipping this material. According to reports the producers could not supply the demand for sand and gravel on account of their inability to get cars, and at least one large company went out of business for this reason. This condition also encouraged the working of roadside pits.

The output of building (including roofing) sand and gravel increased 23 per cent in 1922, but the quantity of sand and gravel used for paving and road making increased only 9 per cent.

Sand and gravel produced and sold in the United States, 1919–1922, by kinds, in short tons.

Kind.	1919	1920	1921	1922
Glass sand	1,827,409	2,165,926	1,280,359	1,768,549
Molding sand	3,774,612	5,128,075	1,906,977	3,839,116
Building sand	21,969,736	26,539,365	24,565,605	29,375,466
Grinding and polishing sand	988,240	1,132,810	910,670	1,183,161
Fire or furnace sand	355,458	400,953	204,655	237,065
Engine sand	1,481,481	1,754,897	1,302,739	1,685,712
Paving sand	4,431,306	5,920,328	7,529,522	10,669,772
Filter sand	58,342	83,983	103,914	71,728
Other sands	1,083,152	649,805	490,513	864,354
Railroad ballast	8,715,842	9,081,815	8,949,274	9,053,502
Gravel (exclusive of railroad ballast)	25,890,829	29,183,431	32,600,780	36,118,621
	70,576,407	82,041,388	79,845,008	94,867,046

Sand and gravel produced and sold in the United States in 1922, by States and uses.

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire or furnace sand.		Engine sand.		Paving sand.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama			25,991	$23,052	390,074	$180,656	600	$425			3,000	$1,750	22,315	$10,694
Arizona					54	18							144,620	101,234
Arkansas	(a)	(a)			129,718	97,807					(a)	(a)	71,831	61,090
California	5,374	$11,625	19,614	36,184	2,589,120	1,686,853	588	1,574	(a)	(a)	(a)	(a)	471,184	339,115
Colorado					31,837	16,142					30,373	18,828	(a)	(a)
Connecticut			1,354	2,038	188,401	94,448					2,282	877	43,215	33,600
Delaware			470	1,046	15,881	15,934	100	335	710	$1,680			15,301	11,476
District of Columbia					(a)	(a)							(a)	(a)
Florida					165,549	99,069					3,900	900	(a)	(a)
Georgia	5,478	6,300	37,070	17,908	383,249	148,042	850	510			8,945	2,895	10,125	7,365
Hawaii														
Idaho					2,040	1,715							43,800	16,200
Illinois	488,641	562,994	654,761	606,779	2,330,674	1,315,344	82,367	140,574	(a)	(a)	156,407	62,955	1,014,926	490,814
Indiana	63,579	20,381	396,916	150,781	924,845	463,021	8,326	5,025	13,350	4,940	80,751	30,531	980,887	467,391
Iowa			29,809	32,613	842,254	466,326	6,225	6,961			59,778	27,568	286,303	146,030
Kansas					1,078,555	620,129					13,420	7,550	228,298	128,399
Kentucky	(a)	(a)	39,369	53,161	419,473	290,695	(a)	(a)	(a)	(a)	17,252	14,941	147,487	112,960
Louisiana	(a)	(a)			336,428	171,561					1,000	750	(a)	(a)
Maine					48,713	43,129	900	1,193			3,937	2,386	1,627	1,449
Maryland	21,825	29,049	(a)	(a)	731,290	551,355	(a)	(a)			27,059	38,501	113,000	77,250
Massachusetts	2,201	14,483	14,916	13,428	730,328	617,967	3,369	5,002	9,500	7,600	52,044	61,246	33,796	20,722
Michigan	56,256	148,328	147,516	40,862	858,764	445,970	161,771	26,681	2,346	2,933	3,135	1,128	731,933	342,499
Minnesota	(a)	(a)	21,492	21,494	505,421	257,953	23,133	48,239	(a)	(a)	18,940	7,293	295,660	145,057
Mississippi					87,504	53,775					(a)	(a)	(a)	(a)
Missouri	(a)	(a)	110,984	110,857	495,594	236,477	(a)	(a)	2,500	2,250	4,855	3,380	316,834	137,630
Montana			60	160	2,124	2,508							13,813	10,191
Nebraska			6,000	4,500	636,459	235,469					36,635	10,440	145,750	56,256
Nevada					1,380	460					12,876	1,555		
New Hampshire					92,046	74,735					5,751	2,130	49,000	31,850
New Jersey	174,122	277,467	468,992	554,867	1,977,013	934,434	87,812	193,619	43,374	55,126	68,178	41,397	777,891	379,252
New Mexico			(a)	(a)	(a)	(a)	(a)	(a)			10,915	5,603	1,494	1,264
New York	(a)	(a)	579,999	855,682	4,588,446	2,171,806			17,479	14,193	176,707	97,444	531,801	366,438
North Carolina					191,859	77,697					11,949	5,587	93,484	45,668
North Dakota					(a)	(a)								
Ohio	35,111	69,902	814,605	1,217,664	2,384,757	1,459,973	(a)	(a)	54,601	107,992	67,535	57,485	686,558	432,379
Oklahoma	16,864	27,296			441,655	271,355					13,905	9,516	268,421	174,269
Oregon					336,923	341,365					7,638	2,664	112,147	116,995

Pennsylvania	280,374	521,142	428,782	584,650	2,398,712	2,230,397	583,522	936,377	43,600	80,017	205,927	309,885	890,577	854,129
Rhode Island			10,173	11,861	1,933	2,300								
South Carolina					85,399	43,103	(a)	(a)			(a)	(a)	(a)	(a)
South Dakota					59,020	50,064					(a)	(a)	6,016	2,640
Tennessee			17,550	13,440	451,204	311,854	11,489	7,675	87	78	221,081	213,814	237,180	220,883
Texas	2,146	4,146	1,275	2,445	448,956	323,517	728	582			12,605	9,291	88,340	34,576
Utah					69,482	31,744					16,200	7,200		
Vermont			800	1,230	3,583	1,473	44,645	15,195					10,619	267
Virginia	(a)	(a)	14,118	20,677	281,113	173,221	(a)	(a)			100,073	50,869	288,566	181,565
Washington			(a)	(a)	292,395	125,216	225	142			(a)	(a)	298,059	128,651
West Virginia	434,829	885,413	(a)	(a)	255,316	251,645	6,516	10,382	5,410	11,054	117,902	111,470	219,426	240,401
Wisconsin			81,516	61,532	843,746	403,019	10,209	20,015	(a)	(a)	45,431	19,185	644,067	345,123
Wyoming					15,978	10,425					2,436	2,071	1,680	1,092
Undistributed	181,749	287,840	4,954	6,494	230,201	172,383	146,756	311,963	44,108	48,222	64,887	46,937	331,729	206,737
	1,768,549	2,866,366	3,839,116	4,478,405	29,375,466	17,574,579	1,183,161	1,732,469	237,065	336,085	1,685,712	1,288,022	10,669,772	6,481,601

[a] Included under "Undistributed."

Sand and gravel produced and sold in the United States in 1922, by States and uses—Continued.

State.	Filter sand.		Other sands.		Building gravel.		Paving gravel.		Railroad ballast.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama	1,200	$800			113,367	$69,089	61,222	$32,012	230,974	$28,442	848,743	$346,920
Arizona			(a)	(a)	(a)	(a)	238,130	178,598			386,854	283,600
Arkansas			(a)	(a)	82,359	75,362	257,483	150,742	270,170	86,688	839,773	522,121
California	(a)	(a)	23,592	$14,217	1,123,678	865,497	1,220,982	932,273	475,388	122,746	5,946,892	4,033,856
Colorado			(a)	(a)	13,550	17,808	47,526	58,990	12,863	1,905	139,365	114,651
Connecticut					90,246	68,297					325,498	199,260
Delaware	30	90									32,492	30,561
District of Columbia					(a)	(a)	(a)	(a)			(a)	(a)
Florida			3,900	1,200	20,100	12,655	(a)	(a)			246,849	147,924
Georgia			8,400	3,000	(a)	(a)	(a)	(a)			461,359	191,420
Hawaii							10,131	3,300			10,131	3,300
Idaho					3,700	1,615	30,111	19,245			79,651	38,775
Illinois	(a)	(a)	153,755	98,824	1,448,316	895,276	1,506,920	851,134	967,678	339,514	8,840,293	5,411,821
Indiana			35,904	24,367	572,820	405,622	1,668,440	956,761	1,168,512	448,188	5,824,330	2,977,008
Iowa	12,255	4,682	76,700	36,835	328,297	314,541	757,329	629,549	291,848	87,128	2,690,798	1,752,233
Kansas			38,153	20,730	(a)	(a)			(a)	(a)	1,398,996	790,763
Kentucky			4,746	1,824	360,340	193,836	223,837	149,945	292,262	105,501	1,517,759	937,649
Louisiana					496,291	371,112	711,186	477,648	161,458	82,437	1,711,292	1,106,807
Maine					28,331	38,736	15,709	14,757	962	1,251	100,179	102,901
Maryland			225	450	566,749	786,699	121,692	116,675			1,586,915	1,606,376
Massachusetts	918	2,489	3,094	2,845	535,937	654,293	86,588	57,840	127,890	41,255	1,600,581	1,499,170
Michigan	150	35	6,336	13,064	1,771,565	1,139,580	1,736,002	852,652	484,112	208,311	5,962,916	3,222,043
Minnesota	11,795	40,465	21,466	12,881	536,602	482,338	426,230	305,004	37,667	9,439	1,900,532	1,332,567
Mississippi			33,750	25,000	270,536	212,399	781,003	370,388	564,814	206,586	1,787,497	881,483
Missouri	626	626	29,519	17,372	346,289	142,546	353,979	137,525	102,508	26,845	1,970,345	1,063,370
Montana					14,477	14,917	49,130	28,343			79,604	56,119
Nebraska			7,889	2,083	368,322	273,677	308,920	222,099	3,282	691	1,513,257	805,215
Nevada							363	258	263,737	87,718	278,356	89,991
New Hampshire					46,823	87,529	248,889	161,656			442,509	357,900
New Jersey	16,894	46,786	49,110	54,778	1,058,065	778,798	125,988	107,558	6,994	931	4,854,433	3,425,013
New Mexico			4,075	718	45,873	43,568	(a)	(a)	141,492	65,650	244,315	146,670
New York	(a)	(a)	60,007	38,197	1,947,205	1,261,473	363,520	247,252	(a)	(a)	8,303,392	5,085,312
North Carolina	(a)	(a)	(a)	(a)	203,435	257,002	160,406	192,345	100,494	55,455	764,940	634,924
North Dakota											(a)	(a)
Ohio	(a)	(a)	23,772	30,950	1,324,978	1,047,154	669,756	465,041	886,799	347,026	6,999,962	5,503,374
Oklahoma	(a)	(a)	6,818	2,523	195,323	158,338	390,320	250,160	(a)	(a)	1,357,272	903,043
Oregon			94,426	24,884	407,148	352,302	387,809	307,102	178,736	32,966	1,524,827	1,178,278
Pennsylvania			48,386	55,001	1,506,650	1,107,579	748,599	570,346	217,859	164,163	7,352,988	7,413,686
Rhode Island					335	500					12,441	17,661
South Carolina			(a)	(a)	90,953	123,407	7,031	3,027	108,198	49,215	422,750	297,898
South Dakota			(a)	(a)	29,762	33,091	9,555	7,876	50,659	5,121	200,408	121,690

Tennessee			3,014	2,931	260,903	192,710	325,506	205,211	43,478	24,537	1,571,492	1,193,133
Texas	859	644			842,314	711,147	661,175	336,043	880,707	307,655	2,939,105	1,730,046
Utah					36,850	16,300	28,350	16,800	261,662	80,425	412,544	152,469
Vermont					2,073	628	1,410	200	938	302	64,089	19,295
Virginia	200	200	40,986	22,311	291,547	315,568	445,898	482,702	80,493	33,355	1,570,775	1,333,441
Washington			1,814	827	300,591	135,805	674,104	375,695	234,630	77,700	1,802,121	844,252
West Virginia	(a)	(a)	(a)	(a)	243,019	325,419	257,014	196,958	2,323	1,784	1,553,929	2,063,781
Wisconsin	(a)	(a)	1,718	716	606,392	379,382	1,149,725	716,725	41,251	5,796	3,433,996	1,957,624
Wyoming					36,615	27,374	5,610	3,683	266,082	49,925	328,401	94,570
Undistributed	26,801	45,875	82,799	61,173	117,450	150,200	158,867	181,594	94,582	46,212	629,100	595,700
	71,728	142,692	864,354	569,701	18,686,176	14,541,169	17,432,445	11,373,712	9,053,502	3,232,863	94,867,046	64,617,664

a Included under "Undistributed."

IMPORTS AND EXPORTS.

The quantity of sand and gravel imported in 1922 was 50 per cent less than in 1921. Most of it was building sand and gravel shipped across Lake Erie from Ontario and from Quebec. A great deal of this material comes into the country as ship ballast. The glass-making industry of the Pacific coast obtains white sand from Belgium.

Sand imported for consumption in the United States, 1919–1922.

Year.	Short tons.	Value.	
		Total.	Average.
1919	597,481	$126,586	$0.21
1920	1,226,684	912,282	.74
1921	906,905	771,754	.85
1922	[a] 451,943	[a] 238,386	.53

[a] Includes 65,848 tons of gravel, valued at $27,434, and 1,290 tons of glass sand, valued at $1,112, imported after new tariff went into effect, Sept. 22. Not separately shown prior to that time.

The value of the sand and gravel exported in 1922 showed an increase of 5 per cent. More than 325,000 tons was shipped to Canada. It is not known for what purposes most of the exported sand is used, but over 50,000 tons of that shipped to Canada was used in the manufacture of glass.

Value of sand and gravel exported from the United States in 1919–1922.

Destination.	1919	1920	1921	1922
Canada	$347,578	$583,574	$247,895	$379,692
Mexico	14,803	38,402	97,342	11,891
Panama	4,650	13,367	8,600	75
Japan	3,091	6,758	4,072	.....
England	967	6,161	3,718	2,532
Cuba	2,438	10,746	7,285	677
Newfoundland	279	1,418	854	536
Brazil	40	66	622	338
China	130	833	1,301	97
Argentina	712	58	.....	.....
Other countries	7,382	8,622	8,293	4,361
	382,070	669,945	379,982	[a] 400,199

[a] Represents value of 356,520 short tons. Quantities not recorded prior to 1922.

PRICES.

The only statistics relating to prices of sand and gravel compiled by the Geological Survey are those shown in the following table. These serve as an index of price changes in recent years, which have had a general upward trend from 1917 through 1920, followed by a downward trend.

Values of sand used for every purpose except filtering showed consistent declines in 1922. The average value of gravel used for building and paving dropped from 75 to 72 cents a ton. The value of railroad ballast showed a slight increase and has increased a little each year since 1917.

Average value per short ton of sand and gravel produced and sold in the United States, 1917–1922.

[Based on amounts received for sales f. o. b. pits or nearest shipping points.

Kind.	1917	1918	1919	1920	1921	1922
Glass sand	$1.38	$1.94	$1.97	$2.19	$1.81	$1.62
Molding sand	.92	1.04	1.10	1.46	1.29	1.17
Building sand	.39	.50	.56	.68	a.65	.60
Grinding and polishing sand	1.04	1.60	1.34	1.80	1.61	1.46
Fire or furnace sand	1.15	1.48	1.23	1.81	1.56	1.42
Engine sand	.59	.76	.77	.82	.86	.76
Paving sand	.41	.54	.66	.68	.63	.61
Filter sand	.76	1.47	1.48	1.27	1.11	1.99
Railroad ballast	.17	.22	.30	.32	.33	.36
Gravel (exclusive of railroad ballast)	.46	.57	.66	.81	.75	.72
All kinds	.46	.61	.65	.80	.71	.68

a Revised figures.

GLASS SAND.

There was an increase of 38 per cent in the quantity of glass sand produced in 1922. Illinois, West Virginia, Pennsylvania, New Jersey, and Missouri produced 85 per cent of the total. The average value of the glass sand sold in Illinois was $1.15 a ton, in West Virginia $2.04, in Pennsylvania $1.86, and in New Jersey $1.59.

Glass sand produced and sold in the United States, 1916–1922.

Year.	Short tons.	Value.		Year.	Short tons.	Value.	
		Total.	Average.			Total.	Average.
1916	2,018,317	$1,957,797	$0.97	1920	2,165,926	$4,748,690	$2.19
1917	1,942,675	2,685,014	1.38	1921	1,280,359	2,314,314	1.81
1918	2,172,887	4,209,728	1.94	1922	1,768,549	2,866,366	1.62
1919	1,827,409	3,593,371	1.97				

Localities where glass sand was reported as produced in 1922.

Arkansas: Guion.
California: Ione, Lake Majella.
Georgia: Lumber City.
Illinois: Millington, Oregon. Ottawa, Utica, Wedron.
Indiana: Michigan City.
Kentucky: Lawton.
Louisiana: Le Blanc.
Maryland: Hancock.
Massachusetts: Cheshire.
Michigan: Rockwood.
Minnesota: Ottawa.
Missouri: Crystal City, Gray Summit, Klondike, Pacific.
New Jersey: Cedarville, Clayville, Millville, Penbryn, South Vineland, Williamstown Junction.
New York: Cleveland.
Ohio: Chalfants, Howard, Rushville, Toboso.
Oklahoma: Roff.
Pennsylvania: Daguscahonda, Dunbar, Kennerdell, McVeytown, Mapleton Depot, Parrish.
Texas: Haiduk, Santa Anna.
Virginia: Cape Henry, Cassard, Mendota.
West Virginia: Berkeley Springs, Great Cacapon, Hancock, Sturgisson, Thayer.

MOLDING SAND.

Although the output of molding sand increased 101 per cent, it was 25 per cent less than that produced in 1920. Named in the order of their production, Ohio, Illinois, New York, New Jersey, Pennsylvania, and Indiana supplied 85 per cent of the molding sand produced. The average value in Ohio was $1.53, in Illinois $0.93, in New York $1.48, in New Jersey $1.18, in Pennsylvania $1.36, and in Indiana $0.49.

Molding sand produced and sold in the United States, 1917–1922.

Year.	Short tons.	Value.		Year.	Short tons.	Value.	
		Total.	Average.			Total.	Average.
1917	4,660,968	$4,303,809	$0.92	1920	5,128,075	$7,504,759	$1.46
1918	4,910,178	5,121,865	1.04	1921	1,906,977	2,451,966	1.29
1919	3,774,612	4,153,990	1.10	1922	3,839,116	4,478,405	1.17

OTHER SAND.

A little more than 35,000 tons of sand used for fertilizer filler was reported from Indiana, Kentucky, New Jersey, New York, and North Carolina. The average value of this sand was 58 cents a ton.

More than 10,000 tons of sand was used for bedding stock cars; it was reported by producers in Iowa, Nebraska, Oklahoma, and South Dakota. The average value was 38 cents a ton.

A considerable quantity was used for filling for golf courses and tennis courts, and a small tonnage was reported as used in coal washing processes.

The tables of production do not include 63,423 tons of chert, valued at $20,209, produced in Alabama and used for road work.

LIME.

By G. F. Loughlin and A. T. Coons.

GENERAL CONDITIONS.

The industrial reaction from the severe business depression of 1921 was reflected in an increase of 44 per cent in the quantity of lime produced in 1922. The output for 1922 was 2 per cent more than that for 1920, a year of industrial activity in the building and chemical trade. Of the 42 States and Territories that produced lime in 1922, 39 showed an increase in output. This showing is in marked contrast with that for 1921, when the output of only 8 States increased. The 3 States that showed decreases in 1922 are all small producers of lime and serve markets that are largely influenced by local demand. Ten more plants reported operations in 1922 than in 1921. New commercial plants were put into operation during the year, and old plants increased their output, although not to their full capacity. There was considerable activity among the small producers who burn lime for themselves or for local consumption, although in Pennsylvania, where most of these small kilns are operated, the number of operations decreased by 6.

PRODUCTION.

Lime sold in the United States in 1920–1922.

Year.	Short tons.	Value.[a]		Number of plants in operation.
		Total.	Average.	
1920	3,570,141	$37,543,840	$10.52	515
1921	2,532,153	24,895,370	9.83	520
1922	3,639,617	33,255,039	9.14	530
Percentage of increase or decrease in 1922	+44	+34	−7	+2

[a] The value given represents the value of bulk lime f. o. b. at point of shipment and does not include cost of barrel or package.

Lime sold in the United States in 1921 and 1922, by States.

1921.

State.	Rank of State by quantity.	Short tons.	Percentage of total quantity.	Value.	Rank of State by value.	Average value per ton.	Number of plants in operation.
Alabama	8	109,256	4.3	$847,629	9	$7.76	10
Arizona	22	11,783	.5	162,647	22	13.80	3
Arkansas	24	8,958	.3	93,499	25	10.44	3
California	17	42,115	1.7	577,366	15	13.71	7
Colorado	28	5,783	.2	56,956	28	9.85	3
Connecticut	18	(a)	(a)	(a)	13	16.66	5
Florida	23	(a)	(a)	(a)	23	11.93	2
Georgia	27	(a)	(a)	(a)	27	9.71	1
Hawaii	35	1,985	.1	50,690	29	25.54	1
Idaho	41	(a)	(a)	(a)	39	15.07	1
Illinois	14	58,222	2.3	610,197	14	10.48	12
Indiana	11	90,542	3.6	826,311	10	9.13	8
Iowa	29	(a)	(a)	(a)	30	8.67	2
Kentucky	39	1,524	.1	11,551	41	7.58	3
Maine	10	90,585	3.6	1,392,850	5	15.38	4
Maryland	13	64,835	2.6	558,785	16	8.62	17

[a] Included under "Undistributed."

Lime sold in the United States in 1921 and 1922, by States—Continued.

1921—Continued.

State.	Rank of State by quantity.	Short tons.	Percentage of total quantity.	Value.	Rank of State by value.	Average value per ton.	Number of plants in operation.
Massachusetts	4	124,183	4.9	$1,890,512	3	$15.22	10
Michigan	15	48,164	1.9	445,386	19	9.25	6
Minnesota	20	22,109	.9	232,037	20	10.50	5
Missouri	3	159,194	6.3	1,656,560	4	10.41	17
Montana	38	(a)	(a)	(a)	37	13.40	2
Nevada	31	(a)	(a)	(a)	31	10.64	1
New Jersey	37	1,818	.1	14,365	40	7.90	7
New Mexico	32	3,044	.1	33,660	34	11.06	4
New York	12	67,685	2.7	759,299	11	11.22	16
North Carolina	26	(a)	(a)	(a)	26	10.00	1
Ohio	2	471,053	18.6	4,224,579	2	8.97	31
Oklahoma	34	(a)	(a)	(a)	38	9.98	2
Oregon	40	(a)	(a)	(a)	36	21.44	1
Pennsylvania	1	509,891	20.1	4,247,509	1	8.33	183
Porto Rico	33	2,740	.1	44,113	33	16.10	23
Rhode Island	36	(a)	(a)	(a)	35	17.63	1
South Dakota	30	(a)	(a)	(a)	32	10.34	2
Tennessee	9	93,397	3.7	733,639	12	7.86	17
Texas	16	44,404	1.7	452,078	18	10.18	8
Utah	25	7,972	.3	104,605	24	13.12	10
Vermont	19	32,782	1.3	460,318	17	14.04	9
Virginia	7	111,518	4.4	1,005,677	7	9.02	36
Washington	21	17,710	.7	209,761	21	11.84	7
West Virginia	6	119,716	4.7	1,015,690	6	8.48	13
Wisconsin	5	124,078	4.9	999,407	8	8.05	24
Wyoming	42	(a)	(a)	(a)	42	20.98	2
Undistributed		85,107	3.3	1,177,694			
		2,532,153	100.0	24,895,370		9.83	520

1922.

Alabama	6	168,135	4.6	$979,331	9	$5.82	11
Arizona	22	(a)	(a)	(a)	22	13.44	2
Arkansas	26	11,951	.3	115,008	27	9.62	5
California	15	55,161	1.5	683,774	15	12.40	8
Colorado	28	(a)	(a)	(a)	28	10.10	4
Connecticut	18	52,108	1.4	743,742	14	14.27	6
Florida	24	(a)	(a)	(a)	24	11.55	3
Georgia	25	(a)	(a)	(a)	26	10.05	1
Hawaii	38	(a)	(a)	(a)	34	19.88	1
Idaho	40	(a)	(a)	(a)	38	14.08	2
Illinois	13	85,425	2.3	860,945	13	10.08	10
Indiana	11	113,246	3.1	938,645	12	8.29	8
Iowa	29	(a)	(a)	(a)	31	9.35	2
Kentucky	41	1,560	.4	11,062	41	7.09	3
Maine	9	127,840	3.5	1,757,480	5	13.75	4
Maryland	14	71,261	1.9	554,194	17	7.78	21
Massachusetts	7	164,980	4.5	2,510,368	3	15.22	10
Michigan	16	53,635	1.5	484,945	19	9.04	7
Minnesota	20	27,670	.7	307,270	21	11.10	5
Missouri	4	203,984	5.6	1,953,524	4	9.58	16
Montana	35	(a)	(a)	(a)	37	13.39	2
Nevada	23	(a)	(a)	(a)	23	10.32	1
New Jersey	36	2,392	.1	20,845	40	8.71	4
New Mexico	33	3,587	.1	38,520	35	10.74	4
New York	12	96,320	2.6	957,079	10	9.94	16
North Carolina	30	(a)	(a)	(a)	30	10.00	1
Ohio	1	752,916	20.7	6,495,066	1	8.63	29
Oklahoma	37	(a)	(a)	(a)	39	9.00	2
Oregon	39	(a)	(a)	(a)	36	20.05	2
Pennsylvania	2	719,536	19.8	5,581,794	2	7.76	177
Porto Rico	31	5,822	.1	67,636	29	11.62	27
Rhode Island	34	(a)	(a)	(a)	32	17.11	1
South Dakota	32	3,852	.1	43,990	33	11.42	3
Tennessee	10	126,305	3.5	939,039	11	7.43	15
Texas	17	52,552	1.4	524,985	18	9.99	7
Utah	27	11,082	.3	147,087	25	13.27	13
Vermont	19	44,745	1.2	565,498	16	12.64	9
Virginia	8	152,436	4.2	1,251,683	8	8.21	41
Washington	21	25,447	.7	355,412	20	13.97	6
West Virginia	3	219,146	6.0	1,645,055	6	7.50	15
Wisconsin	5	189,558	5.2	1,589,931	7	8.39	24
Wyoming	42	(a)	(a)	(a)	42	25.00	2
Undistributed		96,965	2.7	1,133,131			
		3,639,617	100.0	33,255,039		9.14	530

a Included under "Undistributed."

Pennsylvania, which has long held rank as the principal State in the production of lime, was outranked by Ohio in 1922. Over 70 per cent of the lime produced in Ohio is used for construction, and most of the remainder for the manufacture of chemicals, and both these uses showed large increases in 1922. At present about half of the lime manufactured in Pennsylvania finds use in chemicals, about one-third in construction work, and the remainder in agriculture. Formerly a larger percentage was used for liming the land, and the gradual decrease in the output for this use has been the chief factor in the reduced rank of the State. Also a large part of the chemical lime sold in Pennsylvania is used for metallurgical purposes connected with the manufacture of iron and steel, an industry which did not regain full activity in 1922. The rise of West Virginia from sixth place in 1921 to third place in 1922 is also noteworthy. It was due to the increased manufacture of chemical lime.

The high price and scarcity of coal were obstacles to economical operation in 1922, as in 1921. The use of wood to help conserve coal was noted by the manufacturers. Labor was more plentiful, but cars for transportation of the product were not always available. Prices fluctuated greatly throughout the year but showed a decided downward trend, and the average value per ton for the total United States was 7 per cent less than in 1921.

USES.

Lime sold in the United States in 1921 and 1922, by uses.

Use.	Percentage of total quantity.	Short tons.	Value.	
			Total.	Average.
1921.				
Building	49.0	1,239,486	$13,258,443	$10.70
Agricultural	11.2	284,722	2,237,510	7.86
Chemical:				
Paper mills	9.3	235,855	2,207,938	9.36
Glass works	1.7	43,851	367,796	8.39
Sugar factories	.5	12,225	161,931	13.25
Tanneries	1.9	47,841	481,372	10.06
Metallurgy	6.5	164,245	1,232,748	7.51
Other uses [a]	18.0	456,087	4,372,991	9.59
Total chemical	37.9	960,104	8,824,776	9.19
Dealers	1.9	47,841	574,641	12.01
	100.0	2,532,153	24,895,370	9.83
Hydrated lime (included in totals)		792,970	7,421,637	9.36
1922.				
Building	50.7	1,845,208	18,463,825	10.01
Agricultural	7.5	272,726	2,005,082	7.35
Chemical:				
Paper mills	8.5	310,229	2,683,487	8.65
Glass works	1.7	62,187	463,628	7.46
Sugar factories	.5	16,393	197,878	12.07
Tanneries	1.2	42,978	420,148	9.78
Metallurgy	5.5	200,799	1,458,553	7.26
Other uses [a]	22.9	834,279	6,986,366	8.37
Total chemical	40.3	1,466,865	12,210,060	8.32
Dealers	1.5	54,818	576,072	10.51
	100.0	3,639,617	33,255,039	9.14
Hydrated lime (included in totals)		1,106,063	9,868,980	8.92
Percentage of increase or decrease of hydrated lime in 1922		+39	+33	−5

[a] Details of distribution shown in following table.

Chemical lime sold for "other uses" in 1921 and 1922.

Use.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
Refractories	107,664	$1,113,010	348,838	$2,813,946
Alkalies	[a] 1,589	[a] 14,190	4,275	33,823
Water purification	74,201	741,264	87,432	802,383
Sanitation			2,048	16,480
Calcium carbide	19,597	173,849	(b)	(b)
Bleaching powder	12,551	131,863	20,979	202,308
Calcium acetate	3,776	32,791	13,500	121,788
Silica brick	7,127	61,738	11,707	95,772
Sand-lime and slag brick	5,464	50,851	28,612	256,280
Ammonia works	8,167	75,266	11,847	100,848
Lubricating-grease manufacture	9,584	102,942	3,975	40,655
Coal and water gas purification	2,408	24,951	1,303	14,665
Coke-oven by-products	3,660	33,257	6,370	51,305
Gas-plant by-products	3,582	35,978	6,668	51,592
Soap manufacture	14,249	119,322	19,613	140,135
Glue manufacture	4,014	37,429	4,946	43,066
Spraying	6,800	70,689	8,950	89,445
Cyaniding	5,185	50,737		
Paint manufacture	[c] 1,443	[c] 15,530	[c] 2,503	[c] 23,234
Wood distillation	2,472	19,508	5,963	46,278
Sewage purification	3,422	33,412	2,073	17,931
Corn products	1,117	9,978	(b)	(b)
Gelatin manufacture	1,287	15,892	(b)	(b)
Dairy products	735	2,922	246	2,701
Rubber manufacture	723	10,455	1,923	23,443
Correction of acidity of oils	387	3,917	934	12,216
Salt refining	1,072	10,647	1,278	11,734
Flour mills	(b)	(b)	225	3,234
Disinfectant	1,182	10,223	737	7,146
Manufacture of candles	180	1,701	(b)	(b)
Undistributed [d]	10,814	101,573	12,810	124,610
Unspecified	141,635	1,267,106	224,524	1,839,348
	456,087	4,372,991	834,279	6,986,366

[a] All noncommercial production omitted and included in report on stone as limestone.
[b] Included under "Undistributed."
[c] Includes kalsomine.
[d] Includes in 1921 lime used in the manufacture of precipitated calcium carbonate, indigo, graphite products, varnish, nitrates, food products, polishing and buffing compounds, magnesia, pottery, textiles, dyes, oxygen, medicine, for the renovation of grease, neutralization of acid waters, distillation and dehydration of alcohol, separation of ores, use in flour mills, and for mixture with wood ashes; in 1922, lime used in the manufacture of precipitated calcium carbonate, glycerin, dyes, oxygen, potash, candles, varnish, corn products, gelatin, buffing compounds, gypsum products, proprietary medicine, calcium carbide, explosives, basic magnesium carbonate, distillation and dehydration of alcohol, use in print mills, and for mixture with wood ashes.

It is necessary to classify much material as "unspecified," because many of the manufacturers do not report the uses of the part of their lime which they sell for chemical purposes. It is known to be applied to several of the uses enumerated, but the figures given are the best available.

Lime sold in the United States in 1922, by States and uses.

State.	Building.		Agriculture.		Chemical uses.												Dealers.		Total.	
					Paper mills.		Glass works.		Sugar factories.		Tanneries.		Metallurgy.		Other chemical uses.					
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama	48,471	$392,349	(a)	(a)	(a)	(a)					(a)	(a)	(a)	(a)	89,709	$402,618			168,135	$979,331
Arizona	(a)	(a)					(a)	(a)	(a)	(a)			(a)	(a)	(a)	(a)			(a)	(a)
Arkansas	10,137	100,002	(a)	(a)	(a)	(a)									(a)	(a)			11,951	115,008
California	42,126	518,372	2,756	$35,774					(a)	(a)	(a)	(a)	937	$11,760	8,332	105,242			55,161	683,774
Colorado	(a)	(a)							(a)	(a)			(a)	(a)	(a)	(a)			(a)	(a)
Connecticut	51,631	740,746	(a)	(a)											(a)	(a)			52,108	743,742
Florida	(a)	(a)													(a)	(a)			(a)	(a)
Georgia	(a)	(a)																	(a)	(a)
Hawaii	(a)	(a)	(a)	(a)					(a)	(a)									(a)	(a)
Idaho	(a)	(a)																	(a)	(a)
Illinois	44,632	488,451			14,706	$133,408					5,899	$56,628	1,199	10,452	18,989	172,006			85,425	860,945
Indiana	30,183	247,669	5,017	39,741	31,006	255,470	4,044	$33,158			(a)	(a)	7,509	58,604	33,071	281,211	(a)	(a)	113,246	938,645
Iowa	(a)	(a)																	(a)	(a)
Kentucky	1,335	9,712													(a)	(a)	(a)	(a)	1,560	11,062
Maine	75,154	1,250,749	8,912	48,283	(a)	(a)			(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)			127,840	1,757,480
Maryland	15,687	120,085	44,653	351,482	(a)	(a)							6,373	41,300	5,072	40,664	(a)	(a)	71,261	554,194
Massachusetts	109,922	1,932,083	4,628	19,163	35,400	379,433					(a)	(a)	700	8,170	(a)	(a)			164,980	2,510,368
Michigan	9,030	82,943	(a)	(a)	10,547	92,685	(a)	(a)			2,708	27,649	(a)	(a)	30,908	277,848			53,635	484,945
Minnesota	25,260	283,827											(a)	(a)	(a)	(a)			27,670	307,270
Missouri	64,152	604,009	1,081	11,736	11,241	100,841	(a)	(a)	(a)	(a)	3,885	37,861	8,643	76,145	61,330	575,696	(a)	(a)	203,984	1,953,524
Montana	(a)	(a)																	(a)	(a)
Nevada	(a)	(a)	(a)	(a)									(a)	(a)					(a)	(a)
New Jersey	314	2,463	2,078	18,382															2,392	20,845
New Mexico	1,442	15,870													(a)	(a)	(a)	(a)	3,587	38,520
New York	25,174	250,502	2,751	22,613	19,514	193,354			(a)	(a)	3,637	41,845	11,898	117,426	32,886	325,575	(a)	(a)	96,320	957,079
North Carolina	(a)	(a)									(a)	(a)							(a)	(a)
Ohio	547,875	4,612,581	25,332	177,571	15,448	115,228	56,028	409,861			856	7,137	5,955	54,156	101,422	1,118,532			752,916	6,495,066
Oklahoma	(a)	(a)																	(a)	(a)
Oregon	(a)	(a)															(a)	(a)	(a)	(a)
Pennsylvania	233,088	1,920,087	137,460	1,021,092	55,144	414,491	(a)	(a)	(a)	(a)	4,552	34,243	79,757	522,769	208,213	1,658,576	(a)	(a)	719,536	5,581,794
Porto Rico	398	3,506	599	3,851					4,813	$60,183					12	96			5,822	67,636
Rhode Island	(a)	(a)	(a)	(a)							(a)	(a)			(a)	(a)			(a)	(a)
South Dakota	(a)	(a)											(a)	(a)	(a)	(a)			3,852	43,990

(a) Included under "Undistributed."

Lime sold in the United States in 1922, by States and uses—Continued.

State.	Building.		Agriculture.		Chemical uses.												Dealers.		Total.	
					Paper mills.		Glass works.		Sugar factories.		Tanneries.		Metallurgy.		Other chemical uses.					
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Tennessee	67,299	$535,912	1,392	$11,752	31,592	$204,739	.....	.....	(a)	(a)	1,998	$15,799	.....	.....	20,074	$137,717	(a)	(a)	126,305	$939,039
Texas	37,591	385,307	(a)	(a)	(a)	(a)	.....	.....	600	$5,554	(a)	(a)	(a)	(a)	9,256	86,325	.....	.....	52,552	524,985
Utah	9,325	128,157	(a)	(a)	.....	.....	.....	.....	.....	.....	.....	.....	(a)	(a)	.....	.....	.....	.....	11,082	147,087
Vermont	20,809	297,219	1,111	6,262	7,773	90,030	.....	.....	.....	.....	4,760	63,712	2,122	$19,016	7,994	87,401	176	$1,858	44,745	565,498
Virginia	78,137	713,463	16,420	109,968	11,474	84,558	(a)	(a)	(a)	(a)	3,846	31,173	6,341	46,037	35,718	262,484	.....	.....	152,436	1,251,683
Washington	16,195	246,901	(a)	(a)	(a)	(a)	.....	.....	2,583	39,222	.....	.....	2,017	23,414	834	11,035	.....	.....	25,447	355,412
West Virginia	25,918	212,609	15,287	101,075	(a)	(a)	(a)	(a)	.....	.....	(a)	(a)	(a)	(a)	135,068	1,028,098	.....	.....	219,146	1,643,055
Wisconsin	174,798	1,455,644	657	4,523	9,914	83,832	.....	.....	.....	.....	(a)	(a)	989	6,625	2,880	36,407	(a)	(a)	189,558	1,589,931
Wyoming	(a)	(a)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(a)	(a)
Undistributed	79,125	912,607	3,192	21,814	56,470	535,418	2,115	$20,609	8,397	92,919	10,837	104,101	66,359	462,679	32,511	378,835	54,642	574,214	96,965	1,133,131
	1,845,208	18,463,825	272,726	2,005,082	310,229	2,683,487	62,187	463,628	16,393	197,878	42,978	420,148	200,799	1,458,553	834,279	6,986,366	54,818	576,072	3,639,617	33,255,039

a Included under "Undistributed."

BUILDING LIME.

The output of lime for construction work, which decreased 5 per cent in quantity in 1921, increased 49 per cent in 1922. The revival in constructional activity in the last part of 1921, which kept building lime more nearly normal than any other lime product during that year, continued through 1922. Whether the curtailment of construction early in 1923 and the rise in prices of labor and of some building materials will react on the lime industry in 1923 is uncertain. In 1922 all the prominent States showed increases in output of building lime, ranging from 30 to 70 per cent. Ohio produced 30 per cent of the building lime manufactured in 1922, and 95 per cent of Ohio's product was sold as hydrated lime. Pennsylvania produced 13 per cent of the building lime, and Wisconsin a little less than 10 per cent.

CHEMICAL LIME.

The output of lime sold for chemical uses increased nearly 53 per cent in 1922, after a decrease of 48 per cent in 1921. The increase was shown by lime for all the principal chemical uses except tanneries. Dead-burned dolomite made the most remarkable increase—224 per cent. Furnaces and smelters that use this product resumed operations during 1922, and all the States supplying these plants showed marked increase in sales. Dead-burned dolomite is produced at Ensley, Ala.; Natural Bridge, N. Y.; Peebles (Kenova, W. Va.), Maple Grove, and Beltsville, Ohio; Bainbridge, Plymouth Meeting, and Saginaw, Pa.; and Millville, W. Va. Furnaces and smelters also buy the raw dolomite for use as a refractory material, as may be noted in the report on limestone.

AGRICULTURAL LIME.

The total sales of lime for agriculture decreased 4 per cent in quantity in 1922. Ohio was the only important State to show an increase. Pennsylvania, the principal producing State, decreased 10 per cent, and Maryland, Virginia, and West Virginia also decreased. The decrease of this product is ascribed to the farmers' inability to buy lime. Ground limestone, which for several years increased in output as burned lime decreased, has since 1919 also decreased. In 1922 the production of ground limestone was 9 per cent less than in 1921. Sales of calcareous marl and oyster-shell lime for agricultural purposes, as shown below, increased in quantity 13 and 29 per cent, respectively, in 1922. It will be noted that while the total sales of lime from limestone decreased 4 per cent, sales of hydrated lime for this purpose increased 5 per cent.

Different kinds of agricultural lime sold in 1921–22.

	Short tons.		Value.	
	Gross.	Effective lime content.	Total.	Average.
1921.				
Lime from limestone:				
Quicklime	142,140	119,400	$940,318	$6.62
Hydrated	142,582	99,800	1,297,192	9.10
Lime from oyster shells	24,315	20,400	197,092	8.11
Limestone (pulverized)	1,311,520	564,000	2,355,339	1.80
Calcareous marl	59,730	25,700	195,743	3.28
1922.				
Lime from limestone:				
Quicklime	122,303	102,700	750,188	6.13
Hydrated	150,423	105,300	1,254,894	8.34
Lime from oyster shells	31,439	26,400	248,911	7.92
Limestone (pulverized)	1,195,000	513,850	2,150,435	1.80
Calcareous marl	67,777	29,100	203,196	3.00

The means by which the effective lime content of the different forms of land lime is calculated was discussed in the report for 1921. In 1922 producers of pulverized limestone were asked to report the grading of the material sold by them as a more effective means of determining this factor, but the replies were so indefinite that it was impossible to obtain any more complete information.

Detailed statistics of pulverized limestone sold for agriculture in 1922 will be found in the annual report on stone. All the calcareous marl sold in the United States in 1922 was used for liming the soil. Virginia produced 28,971 short tons, valued at $57,887. New deposits for the production of this material were opened in California in 1922, and the output for the State was 16,231 short tons, valued at $75,109. The other producing States were Arkansas (chalk), Maryland, New York, North Carolina, Ohio, Pennsylvania, West Virginia, and Wisconsin.

The burning of lime from oyster shells is an industry of minor importance in Maryland, Virginia, Pennsylvania, and New Jersey. The production in Virginia in 1922 was 18,561 short tons, valued at $163,566, and in Maryland 9,878 short tons, valued at $64,945. This lime is sold almost entirely for agriculture, but some of it is also sold to chemical works.

HYDRATED LIME.

In presenting the output of hydrated lime it is the intention of the United States Geological Survey to include only the product made in hydrating machines and to omit hand-slacked lime. There were nine more plants reported as producing hydrated lime in 1922 than in 1921. Hydrated lime increased 39 per cent in quantity and 33 per cent in value in 1922 and for the first time showed a total production of over 1,000,000 tons.

Hydrated lime sold in the United States, 1920–1922.

Year.	Short tons.	Value.		Number of plants in operation.
		Total.	Average.	
1920	853,116	$9,287,562	$10.89	98
1921	792,970	7,421,637	9.36	105
1922	1,106,063	9,868,980	8.92	114

Hydrated lime sold in the United States in 1921 and 1922, by uses.

Use.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
Building	539,550	$4,996,718	800,353	$7,135,264
Agriculture	142,582	1,297,192	150,423	1,254,894
Chemical:				
Paper mills	4,840	48,270	10,305	101,945
Sugar factories	4,633	38,628	6,337	59,943
Tanneries	14,872	153,336	16,736	167,318
Glass factories	1,299	12,934	1,833	19,881
Metallurgy	2,453	21,921	1,930	19,085
Other uses	69,612	718,285	101,510	956,334
Total chemical	97,709	993,374	138,651	1,324,506
Dealers	13,129	134,353	16,636	154,316
	792,970	7,421,637	1,106,063	9,868,980

Hydrated lime sold in the United States in 1921 and 1922, by States.

State.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
Alabama	7,030	$66,480	15,016	$140,698
Arizona	(a)	(a)	(a)	(a)
California	(a)	(a)	(a)	(a)
Colorado			(a)	(a)
Connecticut	(a)	(a)	(a)	(a)
Florida	(a)	(a)	(a)	(a)
Georgia	(a)	(a)	(a)	(a)
Hawaii	164	4,264	160	3,633
Illinois	11,034	115,505	13,004	129,132
Indiana	29,605	276,665	38,832	344,775
Maine	(a)	(a)	(a)	(a)
Maryland	33,553	320,600	40,976	356,937
Massachusetts	(a)	(a)	(a)	(a)
Michigan	(a)	(a)	(a)	(a)
Minnesota	(a)	(a)	(a)	(a)
Missouri	45,903	487,169	56,024	551,187
Nevada	(a)	(a)	(a)	(a)
New Jersey	(a)	(a)	(a)	(a)
New York	(a)	(a)	(a)	(a)
Ohio	344,669	2,991,407	537,816	4,519,990
Pennsylvania	135,917	1,311,678	172,179	1,571,709
Rhode Island	(a)	(a)	(a)	(a)
South Dakota	(a)	(a)	(a)	(a)
Tennessee	25,719	233,266	26,029	231,120
Texas	19,634	205,885	21,163	203,687
Utah	(a)	(a)	(a)	(a)
Vermont	(a)	(a)	(a)	(a)
Virginia	11,159	101,009	15,284	123,039
Washington	(a)	(a)	(a)	(a)
West Virginia	38,335	319,874	49,712	369,122
Wisconsin	15,411	151,794	21,680	218,557
Undistributed	74,837	836,041	98,188	1,105,394
	792,970	7,421,637	1,106,063	9,868,980

KILNS, FUEL, AND CAPACITY OF PLANTS.

In the following table the capacity of most of the field kilns is omitted as negligible, and the figures are also short by a small percentage, owing to the lack of information for a few plants. It may be noted, however, that the total reported capacity of 19,429 tons a day, based on a full 300-day running time, is 60 per cent more than the actual production.

Daily capacity, number of kilns, and kind of fuel used in burning lime in 1922.

State.	Daily capacity (short tons).	Total kilns in plants.	Active kilns in 1922.											
			By kind.					By fuel used.						
			Pot.	Patent.	Gas.	Rotary.	Field and unspecified.	Coal.	Wood.	Oil.	Natural gas.	Producer gas.	Coke.	Coal and wood.
Alabama	692	37	6	21	....	....	1	17	1	....	....	....	2	8
Arizona	115	10	.....	6	....	....	.....	.....	6	....	....	....	.....	....
Arkansas	110	12	1	5	....	....	1	.....	7	....	....	....	.....	....
California	233	36	8	19	....	4	1	1	3	28	....	....	.....	....
Colorado	30	7	1	1	3	....	1	3	.....	....	....	3	.....	....
Connecticut	338	36	.....	21	....	....	.....	19	2	....	....	....	.....	....
Florida	35	19	6	6	....	....	.....	.....	10	1	....	....	1	....
Georgia	80	8	.....	8	....	....	.....	8	.....	....	....	....	.....	....
Hawaii	24	2	.....	1	....	....	.....	.....	.....	1	....	....	.....	....
Idaho	36	6	3	.....	....	....	1	.....	4	....	....	....	.....	....
Illinois	429	41	6	16	4	....	8	9	.....	....	1	3	.....	[a] 21
Indiana	632	65	5	37	2	....	1	43	.....	....	2	....	.....	....
Iowa	78	6	2	2	....	....	.....	.....	2	....	....	....	.....	2
Kentucky	12	3	.....	1	....	....	2	1	2	....	....	....	.....	....
Maine	473	57	.....	44	6	....	.....	29	15	....	....	6	.....	....
Maryland	785	106	53	7	....	....	8	44	3	....	....	....	18	[b] 3
Massachusetts	953	55	.....	33	6	4	.....	14	8	4	....	6	.....	11
Michigan	328	23	.....	15	....	1	2	3	15	....	....	....	.....	....
Minnesota	167	25	14	10	....	....	.....	9	1	14	....	....	.....	....
Missouri	829	71	.....	41	20	....	.....	16	22	....	....	15	1	7
Montana	20	2	.....	1	....	....	1	2	.....	....	....	....	.....	....
Nevada	45	1	.....	.....	....	1	.....	.....	.....	1	....	....	.....	....
New Jersey	55	9	7	.....	....	....	1	3	.....	....	....	....	5	....
New Mexico	25	4	.....	1	....	....	3	2	1	....	....	....	.....	[c] 1
New York	703	37	7	16	....	4	3	27	2	....	....	1	.....	....
North Carolina	.....	4	4	.....	....	....	.....	4	.....	....	....	....	.....	....
Ohio	4,036	363	7	281	8	5	5	259	.....	6	40	....	.....	1
Oklahoma	12	1	.....	1	....	....	.....	.....	1	....	....	....	.....	....
Oregon	30	4	3	.....	....	....	1	1	.....	....	....	....	.....	3
Pennsylvania	3,555	741	133	223	3	2	115	383	1	3	....	5	84	....
Porto Rico	.....	6	.....	.....	6	....	.....	6	.....	....	....	....	.....	....
Rhode Island	25	4	.....	2	....	....	.....	.....	2	....	....	....	.....	....
South Dakota	29	7	1	1	....	....	1	2	1	....	....	....	.....	....
Tennessee	647	72	10	36	8	....	1	40	7	....	....	....	.....	8
Texas	289	29	3	20	....	....	.....	23	.....	....	....	....	.....	....
Utah	67	17	7	3	....	....	6	12	.....	....	....	....	4	....
Vermont	315	31	11	4	1	1	.....	2	9	....	....	2	.....	4
Virginia	987	113	19	62	3	....	12	83	3	....	....	3	4	3
Washington	225	21	2	11	....	....	.....	.....	11	....	....	....	2	....
West Virginia	795	61	18	18	3	2	10	30	.....	....	....	3	18	....
Wisconsin	1,190	91	10	44	....	....	4	4	41	13	....	....	.....	....
	19,429	2,246	347	1,018	73	24	189	1,099	180	71	43	47	139	72

[a] Includes 10 kilns using shavings and manure.
[b] Includes 1 kiln using coal and coke.
[c] Using coal, wood, and natural gas.

CONSUMPTION.

Practically all the States showed an increase in per capita consumption in 1922, indicating the general activity of construction and chemical enterprises throughout the country.

The lime produced in Ohio is more widely shipped than that from any other State; that of Missouri and Pennsylvania has the next widest distribution.

Lime consumed in the United States in 1922, by States, in short tons.

State.	Sales.	Shipments from State.	Shipments into State.	Consumption.			Per capita (estimated).		Population Jan. 1, 1923.[a]
				Quicklime.	Hydrated lime.	Total.	1921	1922	
Alabama	168,135	38,242	2,406	123,772	8,527	132,299	0.03	0.05	2,413,092
Alaska			41	41		41	.0006	.0007	[b] 55,036
Arizona	(c)	(c)	2,502	3,551	201	3,752	.01	.01	374,274
Arkansas	11,951	5,816	5,712	9,393	2,454	11,847	.005	.007	1,807,132
California	55,161	3,966	39,250	78,828	11,617	90,445	.015	.024	3,751,111
Colorado	(c)	(c)	9,882	13,837	2,569	16,406	.014	.017	983,078
Connecticut	52,108	37,353	23,652	33,026	5,381	38,407	.025	.026	1,462,790
Delaware			21,812	11,072	10,740	21,812	.077	.095	229,394
District of Columbia			21,626	10,628	10,998	21,626	.031	.049	[b] 437,571
Florida	(c)	(c)	15,704	14,192	14,738	28,930	.021	.028	1,035,170
Georgia	(c)	(c)	24,323	12,585	22,254	34,839	.006	.012	2,984,429
Hawaii	(c)		(c)	4,560	1,767	6,327	.018	.022	275,688
Idaho	(c)	(c)	1,238	1,641	182	1,823	.002	.004	464,705
Illinois	85,425	28,586	223,628	217,348	63,119	280,467	.025	.04	6,746,917
Indiana	113,246	61,205	48,960	51,763	49,238	101,001	.02	.03	3,001,314
Iowa	(c)	(c)	32,260	19,753	18,260	38,013	.01	.02	2,459,411
Kansas			25,664	14,440	11,224	25,664	.01	.01	1,793,456
Kentucky	1,560		25,766	17,982	9,344	27,326	.007	.01	2,455,790
Louisiana			33,512	24,558	8,954	33,512	.01	.02	1,842,427
Maine	127,840	78,496	27,817	70,454	6,707	77,161	.07	.10	775,938
Maryland	71,261	31,270	70,036	63,012	47,015	110,027	.05	.07	1,497,347
Massachusetts	164,980	132,786	84,738	99,288	17,644	116,932	.02	.03	4,002,518
Michigan	53,635	9,335	110,616	81,780	73,136	154,916	.03	.04	3,933,619
Minnesota	27,670	13,386	15,763	16,668	13,379	30,047	.011	.012	2,483,357
Mississippi			12,400	10,591	1,809	12,400	.005	.007	[b] 1,790,618
Missouri	203,984	134,858	25,548	73,183	21,491	94,674	.019	.028	3,438,268
Montana	(c)	(c)	1,242	3,153	677	3,830	.007	.006	602,298
Nebraska			15,272	9,880	5,392	15,272	.006	.01	1,328,557
Nevada	(c)	(c)	1,650	1,618	32	1,650	.04	.02	[b] 77,407
New Hampshire			18,398	17,014	1,384	18,398	.03	.04	446,948
New Jersey	2,392		164,717	80,451	86,658	167,109	.03	.05	3,347,097
New Mexico	3,587	683	1,164	3,489	579	4,068	.009	.01	370,563
New York	96,320	40,124	343,487	259,557	140,126	399,683	.02	.04	10,778,171
North Carolina	(c)	(c)	60,778	43,372	22,280	65,652	.017	.025	2,668,153
North Dakota			11,499	10,586	913	11,499	.002	.017	668,446
Ohio	752,916	543,327	73,126	138,972	143,743	282,715	.03	.05	6,066,019
Oklahoma	(c)	(c)	35,149	30,506	5,575	36,081	.007	.017	2,142,966
Oregon	(c)	(c)	4,992	4,554	1,293	5,847	.006	.007	817,572
Pennsylvania	719,536	251,753	222,873	533,509	157,147	690,656	.05	.076	9,045,997
Porto Rico	5,822			5,822		5,822	.002	.004	1,355,986
Rhode Island	(c)	(c)	14,058	15,299	1,454	16,753	.018	.027	623,190
South Carolina			12,513	7,509	5,004	12,513	.005	.007	1,735,739
South Dakota	3,852	625	4,078	5,545	1,760	7,305	.01	.02	652,820
Tennessee	126,305	83,156	7,020	36,337	13,832	50,169	.011	.021	2,385,193
Texas	52,552	11,087	1,287	24,381	18,371	42,752	.007	.009	4,900,145
Utah	11,082	3,142	58	7,172	826	7,998	.013	.017	472,895
Vermont	44,745	36,132	426	8,753	286	9,039	.018	.025	[b] 352,428
Virginia	152,436	101,409	35,561	59,928	26,660	86,588	.03	.036	2,385,690
Washington	25,447	12,140	1,544	13,755	1,096	14,851	.008	.01	1,422,945
West Virginia	219,146	209,810	50,048	45,438	13,946	59,384	.03	.038	1,538,662
Wisconsin	189,558	130,262	45,331	84,199	20,428	104,627	.03	.04	2,724,215
Wyoming	(c)		(c)	2,222	625	2,847	.007	.014	209,369
Undistributed	96,965	44,805	6,812						
	3,639,617	[d]2,043,754	2,037,939	2,530,967	1,102,835	3,633,802	.022	.033	[e]111,642,657

[a] Estimate by Bureau of the Census.
[b] Population Jan. 1, 1920: no estimate made.
[c] Included under "Undistributed."
[d] Inclusive of 5,120 tons shipped to Canada, 555 tons to Mexico, 70 tons to China, 20 tons to Cuba, and 50 tons to the West Indies.
[e] Estimate for continental United States as published by the Bureau of the Census, plus Alaska, Hawaii, and Porto Rico, as shown above.

EXPORTS AND IMPORTS.[1]

Lime exported from the United States, 1920–1922.

Year.	Short tons.	Value.	
		Total.	Average.
1920	5,921	$128,296	$21.67
1921	5,192	109,769	21.14
1922	8,289	116,649	14.07

Lime exported from the United States in 1921–22, by countries.

Country.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
North America:				
Canada	2,465	$34,116	4,419	$49,443
Newfoundland and Labrador	13	317	.....	.....
Mexico	788	20,733	1,663	22,959
Central America:				
British Honduras	6	133	5	104
Honduras	493	14,485	452	6,477
Nicaragua	88	2,410	26	619
Panama	138	5,536	71	1,848
West Indies:				
British—				
Bermuda	10	460	6	123
Jamaica	4	115	9	250
Other British West Indies	21	440	116	2,743
Cuba	40	1,211	135	2,465
Dominican Republic	460	12,404	649	13,473
Virgin Islands of the United States	32	807	13	474
South America:				
Brazil	.....	.....	1	24
Chile	.....	.....	7	176
Colombia	5	162	.....	.....
Ecuador	.....	.....	(a)	21
Peru	460	12,672	316	6,877
Venezuela	.....	.....	1	18
Europe:				
England	6	400	20	320
Sweden	2	66	1	50
Asia:				
China	51	810	40	624
Japan	(a)	10	(a)	18
Philippine Islands	110	2,475	331	7,292
Oceania:				
Australia	.....	.....	8	230
Other British Oceania	.....	.....	(a)	21
French Oceania	(a)	7	.....	.....
	5,192	109,769	8,289	116,649

a Less than 1 ton.

Lime imported and entered for consumption in the United States, 1920–1922.[a]

Year.	Short tons.	Value.	
		Total.	Average.
1920	22,688	$392,137	$17.28
1921	10,811	234,798	21.72
1922	14,112	290,845	20.61

a Most of the lime imported into the United States comes from Canada.

[1] Statistics of exports and imports compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

MINERAL WATERS.

By W. D. Collins.[1]

SCOPE OF REPORT.

The term "mineral water" as here used applies to water that is bottled and sold in its natural state or only slightly altered from its natural state. It includes (*a*) natural carbonated waters that have lost part of their carbon dioxide; (*b*) natural waters that have been artificially carbonated; and (*c*) waters from which iron has been removed. It does not include artificial waters or natural waters that have been essentially modified in chemical character.

The statistics in this report refer only to domestic mineral waters that have been sold. Water that is given away, including water furnished free for drinking or bathing to guests at hotels or to patients at sanitariums, has been omitted, even where data are available to show the quantity of water so used. Hence, as actual sales fall far short of the total quantity used, particularly of such waters as are drunk at resorts for their medicinal value, the totals do not represent the full magnitude of the trade.

Three uses of mineral waters are recognized in this report—table use, medicinal use, and use in manufacture of soft drinks—but the quantity and value of water used in the manufacture of soft drinks are not included in the totals. In former reports the springs whose waters were used only for making soft drinks were included in the number of producing springs. In this report such springs are enumerated separately.

The distinction for statistical purposes between table and medicinal waters is entirely arbitrary and is based on the reports furnished by the owners and operators of springs stating the uses for which the waters are sold.

The list of springs and wells on pages 211–220 includes all for which reports of sales of water in 1922 were received and some whose waters were reported to be used only in the manufacture of soft drinks.

[1] The statistics showing production were compiled by Mrs. E. R. Phillips, of the United States Geological Survey. Those showing imports and exports were compiled by J. A. Dorsey from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

MINERAL-WATER TRADE IN 1922.

OUTPUT AND VALUE.

Mineral waters sold in the United States in 1921 and 1922, by States.

[Exclusive of water used in the manufacture of soft drinks.]

State.	1921		1922			
	Gallons.	Value.	Gallons.	Value.	Percentage of increase or decrease.	
					Quantity.	Value.
Alabama	892	$690	5,389	$875	+504	+27
Arkansas	313,322	31,984	248,460	28,866	−21	−10
California	3,260,609	367,313	3,048,324	433,711	−7	+18
Colorado	234,560	70,925	146,626	55,283	−37	−22
Connecticut	866,253	50,679	1,141,421	70,926	+32	+40
Florida	321,472	28,365	1,004,984	57,305	+213	+102
Georgia	306,637	22,757	424,290	36,856	+38	+62
Illinois	351,277	21,871	335,974	18,679	−4	−15
Indiana	541,190	158,790	514,211	156,358	−5	−2
Iowa	21,100	2,105	25,561	3,788	+21	+80
Kansas	421,294	55,982	383,600	64,554	−9	+15
Kentucky	255,475	37,174	191,275	30,430	−25	−18
Maine	744,775	309,757	928,149	368,939	+25	+19
Maryland	888,948	87,138	749,624	73,890	−16	−15
Massachusetts	1,088,921	72,792	1,417,111	81,674	+30	+12
Michigan	1,344,900	154,401	1,229,802	150,237	−9	−3
Minnesota	2,266,578	132,127	2,962,160	156,066	+31	+18
Mississippi	140,600	31,945	100,548	25,966	−28	−19
Missouri	176,541	45,670	141,369	40,149	−20	−12
New Hampshire	225,720	9,599	(a)	(a)	.....	.....
New Jersey	250,295	25,960	290,808	30,800	+16	+19
New York	5,965,049	736,173	6,965,638	800,831	+17	+9
North Carolina	87,052	13,561	65,020	9,941	−25	−27
North Dakota	585,000	8,100	(a)	(a)	.....	.....
Ohio	2,219,149	161,208	2,298,132	162,814	+4	+1
Oklahoma	1,319,895	45,078	1,434,885	46,047	+9	+2
Oregon	2,150	653	2,621	598	+22	−8
Pennsylvania	730,252	74,490	824,988	81,435	+13	+9
Rhode Island	327,352	21,391	279,109	25,704	−15	+20
South Carolina	124,055	18,489	96,900	21,622	−22	+17
South Dakota	(a)	(a)	796,500	32,850	.....	.....
Tennessee	1,150,585	72,227	1,005,119	67,838	−13	−6
Texas	366,429	67,410	307,478	50,737	−16	−25
Vermont	4,500	468	(a)	(a)	.....	.....
Virginia	902,034	122,283	840,113	111,879	−7	−9
West Virginia	412,595	37,205	380,726	32,137	−8	−14
Wisconsin	5,665,797	1,726,333	6,126,143	2,120,669	+8	+23
Undistributed b	897,985	53,352	1,779,823	47,815	.....	.....
	34,781,238	4,876,445	38,492,881	5,498,269	+11	+13

a Included under "Undistributed."

b 1921: Louisiana, Montana, Nevada, New Mexico, South Dakota, Washington, and Wyoming; 1922: Louisiana, Montana, Nevada, New Hampshire, New Mexico, North Dakota, Vermont, Washington, and Wyoming.

Value of medicinal and table waters sold in the United States in 1922.

State.	Medicinal waters.	Table waters.	Total.	State.	Medicinal waters.	Table waters.	Total.
Arkansas	$22,885	$5,981	$28,866	Connecticut, New Hampshire, New Jersey, Vermont [a]	$8,928	$102,703	$111,631
California	105,931	327,780	433,711	North Carolina, South Carolina [a]	23,909	7,654	31,563
Colorado	3,345	51,938	55,283	Alabama, Florida [a]	13,624	44,556	58,180
Georgia	2,998	33,858	36,856	Kentucky, West Virginia [a]	27,498	35,069	62,567
Indiana	137,671	18,687	156,358	Louisiana, New Mexico, Texas [a]	51,453	17,550	69,003
Kansas	51,365	13,189	64,554	Illinois, Iowa [a]	1,445	21,022	22,467
Maine	87,655	281,284	368,939	Michigan, Minnesota [a]	1,011	305,292	306,303
Maryland	.....	73,890	73,890	Montana, North Dakota, Washington [a]	5,378	8,004	13,382
Massachusetts	3,717	77,957	81,674	Nevada, Oregon, Wyoming [a]	595	6,265	6,860
Mississippi	25,966	.....	25,966		830,085	4,668,184	5,498,269
Missouri	31,760	8,389	40,149				
New York	103,513	697,318	800,831				
Ohio	8,371	154,443	162,814				
Oklahoma	997	45,050	46,047				
Pennsylvania	6,961	74,474	81,435				
Rhode Island	.....	25,704	25,704				
South Dakota	.....	32,850	32,850				
Tennessee	15,525	52,313	67,838				
Virginia	77,599	34,280	111,879				
Wisconsin	9,985	2,110,684	2,120,669				

[a] Combined according to locality to avoid disclosing confidential information.

CONDITION OF TRADE.

Mineral waters sold in the United States, 1918–1922.

Year.	Number of commercial springs.			Gallons.[b]	Value.[b]	
	Total.	Water used for soft drinks only.	Water sold for table or medicinal use.[a]		Total.	Average (cents).
1918	569	16	553	40,709,722	$4,533,001	11.1
1919	527	26	501	38,697,280	4,880,186	12.6
1920	479	23	456	36,218,260	4,860,915	13.4
1921	456	22	434	34,781,238	4,876,445	14.0
1922	452	19	433	38,492,881	5,498,269	14.3

[a] Water from some of these springs is used also for soft drinks.
[b] Does not include water used for soft drinks.

The mineral-water business on the whole shows comparatively little change from year to year. The number of active springs tends to decrease, the quantity of water sold changes comparatively little, and the average value per gallon increases. These changes are likely to continue as more of the smaller producers find it unprofitable to continue in business. There is still a large field for the sale of bottled waters in cities where the water of the public supply is at times unpalatable. The sale of bottled mineral waters for medicinal use is not likely to increase greatly, but the building up of health and pleasure resorts around springs offers opportunities to those who have the necessary means, inclination, and experience.

SOFT DRINKS.

Mineral waters used in the manufacture of soft drinks in 1922.

State.	Number of springs.			Gallons.
	Soft drinks only.	Soft drinks and table or medicinal waters.	Total.	
California		8	8	560,080
Colorado		3	3	87,000
Connecticut	3	5	8	341,131
Iowa	1	2	3	168,000
Maine	1	3	4	333,229
Massachusetts	3	5	8	1,106,822
Michigan		4	4	140,850
Minnesota		5	5	218,393
New York		5	5	74,891
Oregon		3	3	9,230
Pennsylvania	1	6	7	488,821
Rhode Island		3	3	118,000
Virginia		3	3	23,079
Wisconsin	5	11	16	777,693
Other States [a]	5	20	25	1,384,416
	19	86	105	5,831,635

[a] Alabama, Georgia, Illinois, Kansas, Kentucky, Louisiana, Maryland, Nebraska, New Hampshire, New Jersey, New Mexico, North Dakota, Ohio, Oklahoma, Vermont, Washington, West Virginia, and Wyoming.

IMPORTS AND EXPORTS.

"General imports" and "imports for consumption" for any period will differ to the extent that the value of entries for warehouse for the period differs from the value of withdrawals from warehouse for consumption. The term "entry for consumption" is the technical name of the import entry made at the customhouse and implies that the goods have been delivered into the custody of the importer and that the duties have been paid on the dutiable portion.

Mineral waters imported for consumption in the United States, 1918–1922.

Year.	Gallons.	Value.	
		Total.	Average (cents).
1918 January to June	258,791	$123,695	48
1918 July to December [a]	200,786	102,970	51
1919 [a]	193,933	112,732	58
1920 [a]	466,547	177,992	38
1921 [a]	498,090	156,297	31
1922	698,751	269,245	39

[a] Natural mineral waters exclusively. Figures for first half of 1918 and for 1922 include artificial mineral waters and imitation mineral waters, in addition to natural mineral waters.

Mineral waters imported into the United States in 1922,[a] by countries.

[General imports.]

Country.	Gallons.	Value.	Country.	Gallons.	Value.
Austria	143	$68	Hungary	8,027	$1,537
Belgium	1,639	348	Italy	65,903	33,364
Brazil	96	48	Japan	2,627	3,203
Canada	3,273	4,421	Java and Madura	5	12
Cuba	265	176	Netherlands	10,266	4,477
Czechoslovakia	10,906	5,048	New Zealand	7	4
Denmark	127	95	Portugal	60	46
England	5,139	3,629	Spain	10,350	10,460
France	318,362	158,276	Switzerland	148	126
Germany	185,666	24,334			
Honduras	101	39		623,110	249,711

[a] Include artificial and natural water.

Large quantities of a few domestic waters are exported. No statistics regarding such shipments are available for years prior to 1922. In that year the exports of natural and artificial mineral waters amounted to 209,219 gallons, valued at $169,473.

SOURCES OF MINERAL WATERS SOLD IN 1922.

The following list gives the name and location of each spring or well from which sales of water were reported for 1922 and of some whose waters were used only in the manufacture of soft drinks. Most of the bathing and hotel accommodations noted are in establishments conducted by the owners of the springs, and the statements made are those given in the reports made by the owners. The list is far from complete as regards bathing establishments and hotels maintained in connection with mineral springs, because it includes only the names of springs from which water was sold or used for making soft drinks.

Springs or wells from which mineral waters were sold in 1922, by States.

Alabama.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Coldwater Springs	Anniston	Calhoun	
Healing Springs	Healing Springs	Washington	H (70).
Matchless Mineral Wells	Greenville	Butler	
Shocco Springs	Talladega	Talladega	H (35).
White Sulphur Wells	Jackson	Clarke	B, H (100).

Arkansas.

Arsenic Spring	Hot Springs	Garland	(a)
De Soto Spring	do	do	(a)
Happy Hollow Springs	do	do	(a)
Mountain Valley Springs	Mountain Valley	do	H (35).
Potash Sulphur Springs	Hot Springs	do	(a)

[a] Large bathing establishments and hotels maintained at Hot Springs by private persons use water from the springs, which are under Government control.

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

California.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Albion Spring	San Francisco	San Francisco	
Alhambra Springs	Martinez	Contra Costa	
Alma Spring	Alma	Santa Clara	
Arrowhead Springs	Arrowhead Springs	San Bernardino	B, H. [b]
Barcal Mineral Spring	Preston	Sonoma	
Bartlett Springs	Bartlett Springs	Lake	B, H (500).
Beulah Springs	Arlington	Riverside	
Bimini Hot Springs	Los Angeles	Los Angeles	B.
Boyes Springs	Boyes Springs	Sonoma	B,[c] H. [c]
Busch Medical Springs	Potter Valley	Mendocino	
Crystal Springs	Los Angeles	Los Angeles	
Elysian Springs	do	do	
Grizzley Medical Springs	Wilbur Springs	Lake	
Holly Springs	Hollywood	Los Angeles	
Iaqua Medicinal Springs	Eureka	Humboldt	
Melrose Mineral Spring	Los Angeles	Los Angeles	B.
Mok-Hill Mineral Spring	Mokelumne Hill	Calaveras	
Napa Soda Springs	Napa Soda Springs	Napa	H (250).
Napa Vichy Springs	Napa	do	
Norman Medical Springs	Middletown	Lake	B, H (20).
Pope Mineral Springs	Pope Valley	Napa	B, H. [d]
Richardson Springs	Chico	Butte	B, H (250).
Shanghai Spring	Sausalito	Marin	
Shasta Springs	Shasta Springs	Siskiyou	H (120).
Tamalpais Spring	San Rafael	Marin	
Valley Springs	Valley Springs	Calaveras	
Veronica Medicinal Springs	Santa Barbara	Santa Barbara	
Walters Mineral Springs	St. Helena	Napa	B, H (75).
White Rose Spring	Los Angeles	Los Angeles	

Colorado.

Boulder Springs	Salina	Boulder	
Cheyenne Spring	Manitou	El Paso	
Clark Magnetic Mineral Spring	Pueblo	Pueblo	B, H (75).
Green Mineral Well	Canon City	Fremont	
Horn Mineral Springs	Colorado Springs	El Paso	
Lithia Spring	Pueblo	Pueblo	
Lithia Soda Springs	Salina	Boulder	
Little Chief Iron Springs	Manitou	El Paso	
Navajo Spring	do	do	
Ouray Spring	do	do	
Shoshone Spring	do	do	
Ute Spring	do	do	
Waunita Hot Springs	Waunita Hot Springs	Gunnison	B, H (200).
Yampah Spring	Glenwood Springs	Garfield	B, H (600).

Connecticut.

Althea Spring	Waterbury	New Haven	
Bailey Natural Spring	Danbury	Fairfield	
Camp Meeting Spring	Milford	New Haven	
Cherry Hill Spring	Hamden	do	
Crystal Spring	Middletown	Middlesex	
Crystal Spring	Derby	New Haven	
East Hill Spring	do	do	
Elco Springs	Bristol	Hartford	
Gra Rock Spring	Canton	do	
Hillside Spring	Meriden	New Haven	
Hosmer Mountain Spring	Windham	Windham	
Indian Spring	Shelton	Fairfield	
Live Oak Spring	Meriden	New Haven	
Luippold's Mineral Spring	Bridgeport	Fairfield	
Pequot Spring	Glastonbury	Hartford	
Richardson Spring	Torrington	Litchfield	

[b] Used by the United States Government.
[c] Operated not by owners but by others.
[d] Not completed yet.

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

Connecticut—Continued.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Rock Spring	Fairfield	Fairfield	
Rockledge Spring	New Haven	New Haven	
Silver Rock Spring	Middletown	Middlesex	
Stafford Springs	Stafford	Tolland	
Varuna Spring	Stamford	Fairfield	

Florida.

Crystal Springs	Crystal Springs	Pasco	
Elixir Mineral Spring	Hibernia	Clay	
Espiritu Santo Springs	Safety Harbor	Pinellas	B, H (75).
Flamingo Spring	Orange City	Volusia	
Good Hope Mineral Spring	Jacksonville	Duval	
Gra Rock Well	Miami	Dade	
Heilbronn Springs	Starke	Bradford	
Purity Spring	Tampa	Hillsborough	
Wi-Wauchula Spring	Jacksonville	Duval	

Georgia.

Benscot Mineral Springs	Austell	Cobb	
Bowden Springs	Lithia Springs	Douglas	
Cascade Springs	Atlanta	Fulton	
Eureka Springs	Eureka Springs	Dodge	B, H (200).
Fender's Spring	Augusta	Richmond	
High Rock Spring	Atlanta	Fulton	
White Oak Mineral Wells	Macon	Bibb	
Windsor Spring	Augusta	Richmond	

Illinois.

Gravel Springs	Jacksonville	Morgan	
Minerva Mineral Spring	Cary	McHenry	
Montgomery Magnesia Spring	Montgomery	Kane	
Na-mo-no-ma Spring	Dixon Springs	Pope	B, H (60).
Old Ironsides	do	do	
Ripley Mineral Springs	Ripley	Brown	
Sanicula Mineral Springs	Ottawa	La Salle	B.

Indiana.

Bowles Spring	French Lick	Orange	
Carlson Mineral Springs	Laporte	Laporte	
Cartersburg Mineral Spring	Cartersburg	Hendricks	
Greenwood Springs	Fort Wayne	Allen	
Holman Mineral Well	Crawfordsville	Montgomery	
Mount Jackson Mineral Well	Indianapolis	Marion	B.
Pluto Spring	French Lick	Orange	B, H (800).
Proserpine Spring	do	do	
White Crane Well	Dillsboro	Dearborn	B, H (145).

Iowa.

Fry's Well	Colfax	Jasper	
Grand Hotel Mineral Springs	do	do	B, H (68).
Hawkeye Hygeia Well	Sioux City	Woodbury	
Lime Rock Springs	Dubuque	Dubuque	

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

Kansas.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Abilena Wells	Abilene	Dickinson	
Blasing's Springs	Manhattan	Riley	B, H (10).
Crystal Springs	Coffeyville	Montgomery	
Frantz Water Co. Well	Conway Springs	Sumner	
Rockheart Mineral Spring	Parsons	Labette	
Tucker Springs	Kansas City, Kans.	Wyandotte	
Viola Springs	Viola	Sedgwick	
Waconda Springs	Waconda Springs	Mitchell	B, H (70).

Kentucky.

Anita Springs	La Grange	Oldham	
Cole's Lithia Springs	Lexington	Fayette	
Hamby's Genuine Dawson Springs	Dawsonsprings	Hopkins	(*e*)
H. & H. Well	do	do	(*e*)
Kentucky Carlsbad Springs	Dry Ridge	Grant	B, H (68).
Phillips' Wells	Dawsonsprings	Hopkins	B. *e*
Robson Springs	Fort Thomas	Campbell	
Stevens Well	Dawsonsprings	Hopkins	(*e*)

Louisiana.

Krotz Springs	Krotz Springs	St. Landry Parish.	
Ozone Spring	Pearl River	St. Tammany Parish.	

Maine.

Baker Puritan Spring	Old Orchard	York	
Forest Springs	Litchfield	Kennebec	
Glenrock Cold Spring	Greene	Androscoggin	
Glenwood Spring	Augusta	Kennebec	
Hanover Spring	Hanover	Oxford	
Highland Spring	Lewiston	Androscoggin	
Holbrook Hill Spring	Pittsfield	Somerset	
Indian Herm t Mineral Spring	Wells	York	
Keystone Mineral Spring	Poland	Androscoggin	
Mount Desert Spring	Mount Desert	Hancock	H (700).
Mount Kebo Spring	Bar Harbor	do	
Mount Zircon Spring	Rumford	Oxford	
Mystic Spring	Saco	York	
Oak Grove Spring	Brewer	Penobscot	
Paradise Spring	Brunswick	Cumberland	
Pine Spring	Topsham	Sagadahoc	
Poland Mineral Spring	Poland	Androscoggin	H (650).
Rocky Hill Spring	Fairfield	Somerset	
Skowhegan Crystal Spring	Skowhegan	do	
Thorndike Mineral Spring	Thorndike	Waldo	
Wawa Lithia Spring	Wells	York	

Maryland.

Big Rock Spring	Thurmont	Frederick	
Brooklandwood Spring	Brooklandville	Baltimore	
Buena Vista Spring	Edgemont	Washington	
Caton Spring	Catonsville	Baltimore	
Chattolanee Springs	Garrison	do	
Gray Rock Water Co. Spring	Woodlawn	do	
Green Spring	Hagerstown	Washington	
Hygeia Crystal Springs	Annapolis	Anne Arundel	

e Town of Dawsonsprings accommodates 2,000.

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

Massachusetts.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Abbott Spring	Methuen	Essex	
Blue Hill Spring	Milton	Norfolk	
Burnham Spring	Methuen	Essex	
Cascella Springs	Three Rivers	Hampden	
Chelmsford Spring	Chelmsford	Middlesex	
Crystal Spring	Peabody	Essex	
El-Azhar Spring	Tyngsboro	Middlesex	
Klines Spring	Lawrence	Essex	
Goulding Spring	Whitman	Plymouth	
Holyoke Spring	West Lynn	Essex	
King Philip Spring	Mattapoisett	Plymouth	
Lawrence Mineral Spring	Lawrence	Essex	
Monatiquot Spring	Braintree	Norfolk	
Mount Blue Mineral Spring	Hingham	Plymouth	
Mount Holyoke Spring	South Hadley	Hampshire	
Mount Pleasant Spring	Lowell	Middlesex	
Nobscot Spring	Framingham	do	
Norwood Spring	Norwood	Norfolk	
October Spring	Lenox	Berkshire	
Old Homestead Springs	Lawrence	Essex	
Pocahontas Spring	Lynnfield	do	
Polar Spring	Leicester	Worcester	
Purity Spring	Danvers	Essex	
Purity Spring	Lowell	Middlesex	
Robbins Spring	Arlington	do	
Sand Springs	Williamstown	Berkshire	B, H (30).
Shawmut Spring	Quincy	Norfolk	
Simpson Spring	South Easton	Bristol	
Sterling Spring	Lynn	Essex	

Michigan.

Andrews Magnetic Mineral Spring	St. Louis	Gratiot	B, H (200).
Arctic Spring	Grand Rapids	Kent	
Eastman Springs	Benton Harbor	Berrien	H (21).
John Gerick Farm Spring	Denton	Wayne	
Maple Leaf Spring	Mount Clemens	Macomb	
Panacea Spring	do	do	
Silver Springs	Northville	Wayne	
Sultana Mineral Spring	Hartford	Van Buren	
Victory Springs	Mount Clemens	Macomb	

Minnesota.

Clear Spring	Hopkins	Hennepin	
Deep Spring	Crookston	Polk	
Glen Springs	Excelsior	Hennepin	
Glenwood Inglewood Spring	Minneapolis	do	
Highland Spring	St. Paul	Ramsey	
Owens Spring	Glenwood	Pope	
Pokegama Springs	Detroit	Becker	
Red Star Spring	Cold Spring	Stearns	
Rock Spring	Shakopee	Scott	
Ward Springs	Ward Springs	Todd	B, H (84).

Mississippi.

Allisons Well	Way	Madison	B, H (150).
Browns Wells	Hazlehurst	Copiah	H (300).
Red Spring	Stewart	Montgomery	B, H (50).
Robinson Springs	Pocahontas	Hinds	
Stafford Mineral Spring	Vosburg	Jasper	H (80).

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

Missouri.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Apericnt Well	Eldorado Springs	Cedar	
B. B. Springs	Bowling Green	Pike	B, H (50).
Belcher Artesian Well	St. Louis	St. Louis City	B, H (300).
Bokert Springs	De Soto	Jefferson	
Bowling Green Spring	Bowling Green	Pike	
Chalybeate Springs	Halltown	Lawrence	
Chouteau Springs	Boonville	Cooper	B, H (25).
Crystal Mineral Spring	Excelsior Springs	Clay	(*f*)
Crystal Spring	Kansas City	Jackson	
Cusenbary Spring	Mount Washington	do	
Eldorado Laxative Well	Eldorado Springs	Cedar	
Excelsior Saline Well	Excelsior Springs	Clay	(*f*)
Grand River Mineral Springs	Mercer	Mercer	
Haymaker Well	Lineville, Iowa	do	
Hornet Springs	Bowling Green	Pike	
Jackson Spring	Kansas City	Jackson	
Morris Mineral Well	Eldorado Springs	Cedar	
Musick Mineral Well	do	do	
Natrona Spring	Excelsior Springs	Clay	(*f*)
Radium Springs	Seligman	Barry	
Relief Water Co. Well	Excelsior Springs	Clay	(*f*)
Saline Soda Well	do	do	(*f*)
Salt Sulphur Well	do	do	B.*f g*
Sweet Spring	Sweet Springs	Saline	
White Sulphur Spring	Excelsior Springs	Clay	(*f*)

Montana.

Alhambra Hot Springs	Alhambra	Jefferson	B, H (100).
Lissner Mineral Springs	Helena	Lewis and Clark	

Nebraska.

Curo Mineral Springs	Omaha	Douglas	

Nevada.

Diamond Mineral Spring	Reno	Washoe	

New Hampshire.

Granite State Spring	Plaistow	Rockingham	
Mount Madison Spring	Gorham	Coos	

New Jersey.

Belmar Spring	Ridgewood	Bergen	
Echo Spring	Trenton	Mercer	
Indian Spring	Rockaway	Morris	
Indian Lady Hill Springs	Asbury Park	Monmouth	
Rock Spring	West Orange	Essex	
Rosemont Spring	Somerville	Somerset	
Washington Rock Spring	Plainfield	do	
Watchung Springs	do	do	

New Mexico.

Aztec Mineral Springs	Taylor Springs	Colfax	
Coyote Spring	Coyote	Bernalillo	

f Town of Excelsior Springs accommodates 5,000. *g* Furnishes water to six bath houses.

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

New York.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Arlington Spring	Poughkeepsie	Dutchess	B.
Baldwin Mineral Spring	Cayuga	Cayuga	
Biochemic Spring	Jamestown	Chautauqua	
Carrier Spring	Potsdam	St. Lawrence	
Chemung Springs	Chemung	Chemung	
Chester Crest Spring	Mount Vernon	Westchester	
Clinton Lithia Spring	Kirkland	Oneida	
Coesa Spring	Saratoga Springs	Saratoga	(*h*)
Crystalate Spring	Whitesboro	Oneida	
Dietade Mineral Spring	Keeseville	Essex	
Eagle Spring	Lanesville	Greene	
Frontenac Crystal Springs	Clayton	Jefferson	H (21).
Geyser Springs	Saratoga Springs	Saratoga	(*h*)
Gramatan Springs	Bronxville	Westchester	
Great Bear Spring	South Granby	Oswego	
Greendale Crystal Spring	Livingston	Columbia	
Hathorn Spring No. 2	Saratoga Springs	Saratoga	(*h*)
Hides Franklin Mineral Spring	Ballston Spa	do	
Jubilee Spring	Buffalo	Erie	
Mammoth Spring	West Sand Lake	Rensselaer	
Mohawk Spring	Amsterdam	Montgomery	
Morgan Spring	Rensselaer	Rensselaer	
Plymouth Spring	Troy	do	
Quaker Spring	do	do	
Questover Spring	Moores Mill	Dutchess	
Risley Cold Springs	New York Mills	Oneida	
Sans Souci Spring	Ballston Spa	Saratoga	
Saratoga Vichy Spring	Saratoga Springs	do	(*h*)
Sparkling Spring	Buffalo	Erie	
Split Rock Lithia Spring	Kirkland	Oneida	
State Seal Spring	Saratoga Springs	Saratoga	(*h*)
Table Rock Mineral Spring	Mendon	Monroe	
Taconic Spring	Beacon	Dutchess	
Trespur Spring	McGraw	Cortland	
Victoria No. 2 Spring	Saratoga Springs	Saratoga	(*h*)
White Bear Spring	Stafford	Genesee	
White Sulphur Springs	Sharon Springs	Schoharie	B, H (800). *i*

North Carolina.

Derita Spring	Derita	Mecklenburg	
Huckleberry Springs	Durham	West Durham	
Moore's Springs	Moores Springs	Stokes	H (250).
Rivermont Carbonated Spring	Durham	West Durham	
Shelby Lithia Spring	Shelby	Cleveland	

North Dakota.

Granite Spring	Minot	Ward	
Kenmare Spring	Kenmare	do	
Stony Creek Spring	Bowbells	Burke	

Ohio.

Alba Spring	West Park	Cuyahoga	
Beech Rock Spring	Zanesville	Muskingum	
Bellmore Spring	Signal	Columbiana	
Collingwood Springs	Toledo	Lucas	
Crystal Spring	Newark	Licking	
Devonia Mineral Spring	Lorain	Lorain	
Elm Meade Spring	Youngstown	Trumbull	
Fishers Magnesia Mineral Spring	Columbus	Franklin	
Gibson Spring	Youngstown	Mahoning	
Glenwood Mineral Springs	Chillicothe	Ross	H (20).
La France Spring	Toledo	Lucas	
Minnehaha Spring	West Park	Cuyahoga	

h Hotel capacity of city of Saratoga Springs is about 25,000.
i Town of Sharon Springs accommodates 3,000.

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

Ohio—Continued.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Oak Ridge Mineral Springs	Green Springs	Sandusky	B, H (100).
Pine Tree Spring	Willoughby	Lake	
Pure Spring	Akron	Summit	
Purity Spring	South Euclid	Cuyahoga	
Sand Rock Mineral Spring	Canton	Stark	
Sulphur Lick Spring	Chillicothe	Ross	H (75).
Tallewanda Mineral Springs	College Corner	Preble	
Wheeler Mineral Springs	Youngstown	Mahoning	

Oklahoma.

Bromide Spring	Sulphur	Murray	
Everpure Well	Oklahoma City	Oklahoma	
Excelsior Well	do	do	
Guthrie Mineral Wells	Guthrie	Logan	
Kalium Well	Faxon	Comanche	
Lewis Lithia Wells	Oklahoma City	Oklahoma	
Sparkling Water Well	Shawnee	Pottawatomie	
Standard Wells	Tulsa	Tulsa	
White Sulphur Spring	Sapulpa	Creek	
Works Excelsior Mineral Wells	Comanche	Stephens	

Oregon.

Calapooya Springs	Cottage Grove	Lane	B, H (24).
Cascade Mineral Springs	Cascadia	Linn	B, H (50).
Sam-O Springs	Baker	Baker	B.

Pennsylvania.

Carnegie Alkaline Mineral Spring	Carnegie	Allegheny	
Chadwick Mineral Well	Cambridge Springs	Crawford	
Cloverdale Spring	Newville	Cumberland	
Crystal Rock Spring	Temple	Berks	
Dark Hollow Spring	Oakmont	Allegheny	
Ephrata Mountain Crystal Spring	Ephrata	Lancaster	
Great Oak Spring	Pottstown	Chester	
Juniata Springs	Altoona	Blair	
Kecksburg Artesian Mineral Springs	Mammoth	Westmoreland	
Keystone Spring	Taylorsville	Bucks	
Mountain Spring	Reading	Berks	
Mount Laurel Springs	Temple	do	
Original Magnesia Springs	Cambridge Springs	Crawford	
Pavilion Spring	Wernersville	Berks	H (150).
Polar Springs of Pennsylvania	Morrisville	Bucks	
Pulaski Mineral Spring	Pulaski	Lawrence	
Shawnee Mineral Spring	Plymouth	Luzerne	
Sizerville Magnetic Spring	Sizerville	Cameron	
Thurston's Carbonate Springs	Meadville	Crawford	
Tuckahoe Mineral Springs	Northumberland	Northumberland	
Valley Forge Springs	Valley Forge	Chester	
West Nanticoke Artesian Well	West Nanticoke	Luzerne	
White Ribbon Mineral Well	Harrison Valley	Potter	
White Star Spring	Easton	Northampton	

Rhode Island.

Berry Spring	Pawtucket	Providence	
Girard Spring	North Providence	do	
Gladstone Spring	Narragansett Pier	Washington	
Holley Mineral Spring	Woonsocket	Providence	
Ochee Spring	Providence	do	
Prophet Spring	do	do	

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

South Carolina.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Glendale Mineral Spring	Bamberg	Bamberg	
Glenn Springs	Glenn Springs	Spartanburg	H (375).
Mansfield Mineral Springs	Spartanburg	do	
Mertins' Crystal Springs	Augusta, Ga	Aiken	
Shivar Springs	Shelton	Fairfield	

South Dakota.

Culbert Spring	Aberdeen	Brown	
Johnson's Well	Milbank	Grant	
Twin Brooks Springs	Twin Brooks	do	

Tennessee.

Buena Vista Springs	Nashville	Davidson	
Bush Mineral Wells	do	do	
Darnell Well	Clarksville	Montgomery	
Galbraith Epsom Well	Mooresburg	Hawkins	H (125).
Hamilton Springs	Lebanon	Wilson	H (50).
Horn Springs	Hornsprings	do	B, H (200).
Lockeland Spring	Nashville	Davidson	
Pioneer Springs	do	do	
Red and Black Sulphur Springs	Red Boiling Springs	Macon	B, H (275).
Tate Spring	Tate Spring	Grainger	H (380).
Whittle Springs	Knoxville	Knox	H (150).
Willow Brook Spring	Craggie Hope	Cheatham	
Wrights Spring	Mooresburg	Hawkins	

Texas.

Austin Well	Mineral Wells	Palo Pinto	(*j*)
Capps Mineral Wells	Longview	Gregg	
Crazy Wells	Mineral Wells	Palo Pinto	H (500).*j*
Mangum Mineral Well	Mangum	Eastland	
Marlin Hot Well	Marlin	Falls	B.*k*
Mitchell Well	Greenville	Hunt	
Roach Mineral Well	Mount Pleasant	Titus	
Texas Carlsbad Well	Mineral Wells	Palo Pinto	B. *j*
Tioga Mineral Wells	Tioga	Grayson	B, H (100).
Weatherly Wells	Garrison	Nacogdoches	H (50).

Vermont.

Clarendon Nitrogen Spring	Clarendon	Rutland	H (200).
Cold Spring	Wells	do	
Equinox Spring	Manchester	Bennington	

Virginia.

Alkaline Lithia Spring	Staunton	Augusta	
Alleghany Spring	Alleghany Springs	Montgomery	H (75).
Bear Lithia Springs	Elkton	Rockingham	
Beaufont Spring	Richmond	Chesterfield	
Berry Hill Mineral Spring	Elkwood	Culpeper	
Blue Ridge Springs	Blue Ridge Springs	Botetourt	H (200).
Broad Rock Spring	Richmond	Chesterfield	
Buckhead Springs	Buckhead Springs	do	
Buffalo Mineral Springs	Buffalo Lithia Springs	Mecklenburg	H (200).
Burnett Mineral Springs	Culpeper	Culpeper	
Carter Springs	Danville	Pittsylvania	
Calcic Mineral Springs	Norfolk	Norfolk	
Craig Healing Springs	Newcastle	Craig	B, H (450).
Crockett Springs	Crockett Springs	Montgomery	B, H (165).
Farmville Lithia Springs	Farmville	Cumberland	

j Town of Mineral Wells accommodates 8,000. *k* Town of Marlin accommodates 2,500.

Springs or wells from which mineral waters were sold in 1922, by States—Continued.

Virginia—Continued.

Spring or well.	Location.		Bathing establishment (B) and hotel (H), with capacity (number of guests).
	Nearest post office.	County.	
Fonticello Springs	Richmond	Chesterfield	
Healing Springs	Healing Springs	Bath	H (85).
Holly Hill Spring	Charlottesville	Albemarle	
Jeffress Lithia Silica Well	Jeffress	Mecklenburg	H (20).
Lithia Magnesia Springs	Rockymount	Franklin	
Mecklenburg Well	Chase City	Mecklenburg	
Mico Well	Alexandria	Alexandria	
Nye Mineral Springs	Wytheville	Wythe	
Panacea Springs	Hopewell	Prince George	
Picketts Radio-active Spring	Worsham	Prince Edward	
Rockbridge Alum Springs	Rockbridge Alum Springs.	Rockbridge	
Rubino Healing Springs	Healing Springs	Bath	
Seawright Mineral Springs	Staunton	Augusta	
Virginia Etna Springs	Vinton	Roanoke	
Wyrick Spring	Crockett	Wythe	H (40).

Washington.

Artesian Mineral Springs	Yakima	Yakima	B.
Klickitat Mineral Springs	Klickitat	Klickitat	
Sol Duc Hot Springs	Sol Duc	Clallam	B, H (80).

West Virginia.

Hamletts Sulphur Well	Alderson	Monroe	H (75).
Man-a-cea Water-Irondale Spring	Independence	Preston	
Pence Springs	Pence Springs	Summers	H (300).
Saline Chalybeate Spring	Wheeling	Ohio	
Vigora Spring	do	do	

Wisconsin.

Allouez Spring	Green Bay	Brown	
Arbutus Natural Mineral Spring	Oconto	Oconto	
Artesia Spring	Milwaukee	Milwaukee City	
Bethania Mineral Springs	Osceola	Polk	
Bethesda Spring	Waukesha	Waukesha	
Clysmic Spring	do	do	
Crystal Spring	Sheboygan	Sheboygan	
Darlington Mineral Spring	Darlington	Lafayette	
Douglas Spring	Walworth	Walworth	
Glenn Rock Waukesha Spring	Waukesha	Waukesha	
Hydrox Spring	Palmyra	Jefferson	
Indian Mineral Spring	Menomonee Falls	Waukesha	
Maribel Mineral Spring	Maribel	Manitowoc	
Nee-Ska-Ra Spring	Milwaukee	Milwaukee	
Old Faithful Spring	Wauwatosa	do	
Salvator Spring	Green Bay	Brown	
Sheridan Mineral Springs	Lake Geneva	Walworth	
Silurian Spring	Waukesha	Waukesha	
Silver Spring	Madison	Dane	
Solon Springs	Solon Springs	Douglas	
Sparkling Spring	Kenosha	Kenosha	
Still Rock Spring	Waukesha	Waukesha	
Sulphur Mineral Springs	Oshkosh	Winnebago	
Waukesha Fox Head Spring	Waukesha	Waukesha	
White Rock Spring	do	do	
Wilnette Spring	Racine	Racine	

Wyoming.

Big Horn Hot Springs	Thermopolis	Hot Springs	B. *l m*
Paulson Well	Saratoga	Carbon	

l State bath house; free. *m* Town of Thermopolis has three hotels and six apartment houses.

ABRASIVE MATERIALS.

By L. M. Beach and A. T. Coons.

GENERAL SUMMARY.

The statistics in this chapter relate to natural and artificial abrasives used for grinding, polishing, and other abrasive operations. Statistics for abrasive quartz and feldspar are excluded because they can not be precisely separated from those for quartz and feldspar used otherwise, and those materials are therefore considered in other chapters.

The sales of grindstones and pulpstones in 1922 increased less than 1 per cent in quantity and decreased 17 per cent in value compared with 1921. The grindstones sold increased 31 per cent in quantity and 20 per cent in value, and the pulpstones decreased 49 per cent in quantity (short tons) and 41 per cent in value. The demand at paper mills, which were very active late in 1920 and early in 1921 and which during and after the war could not renew their supply of English stone, increased the market for domestic pulpstones in 1921, but the depression that followed this activity caused a decrease in the output of pulpstones in 1922.

The sales of scythestones, oilstones, whetstones, rubbing stones, and hones increased 22 per cent in quantity and 14 per cent in value.

The sales of emery increased 1,163 tons, or 381 per cent, in 1922, and the average value increased to $11.93 a ton, as compared with $7.38 in 1921. There was also an increase of 131 per cent in the quantity of abrasive garnet sold in 1922. The average value of the garnet per ton, however, dropped from $85.53 to $80.36.

There was 22 per cent more pumice sold in 1922 than in 1921, and the average value per ton was $3.88, or 39 cents less.

The output of grinding pebbles and tube-mill lining increased 196 and 331 per cent, respectively.

NATURAL ABRASIVES PRODUCED IN THE UNITED STATES.

Natural abrasives were produced in 1922 in 26 States, which are listed below:

Alabama	Millstones.
Arizona	Pumice.
Arkansas	Oilstones.
California	Diatomaceous earth and grinding pebbles.
Illinois	Tripoli.
Indiana	Oilstones, rubbing stones, and scythestones.
Kansas	Pumice.
Kentucky	Hones.

Maryland	Diatomaceous earth.
Michigan	Grindstones.
Minnesota	Grinding pebbles and tube-mill lining.
Missouri	Tripoli.
Nebraska	Pumice.
Nevada	Diatomaceous earth.
New Hampshire	Diatomaceous earth, garnet, and scythestones.
New York	Diatomaceous earth, emery, garnet, and millstones.
North Carolina	Millstones.
Ohio	Grindstones, pulpstones, oilstones, and scythestones.
Oklahoma	Tripoli.
Oregon	Diatomaceous earth.
Pennsylvania	Rottenstone.
Utah	Diatomaceous earth.
Vermont	Scythestones.
Virginia	Diatomaceous earth, emery, and millstones.
Washington	Diatomaceous earth.
West Virginia	Grindstones and pulpstones.

Natural abrasives produced and sold in the United States, 1920–1922.[a]

Abrasive.	1920		1921		1922	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Millstones	(b)	$63,325	(b)	$24,524	(b)	$20,853
Grindstones and pulpstones	53,484	1,707,004	26,340	1,227,322	26,524	1,020,186
Oilstones and scythestones	1,144	231,747	831	173,025	1,016	197,450
Emery	2,327	21,685	305	2,250	1,468	17,511
Garnet	5,476	434,425	3,048	260,687	7,054	566,879
Abrasive quartz and feldspar	(c)	(c)	(c)	(c)	(c)	(c)
Diatomaceous (infusorial) earth and tripoli[d]	102,155	1,649,370	67,474	895,629	74,966	703,397
Pumice	41,838	114,433	37,108	158,540	45,262	175,600
Grinding pebbles and tube-mill lining	10,924	77,823	989	14,637	3,159	30,798
		4,299,812		2,756,614		2,732,674

[a] More detailed information on abrasive materials will be found in Mineral Resources for 1914 and 1917.
[b] Figures not available, as product was not reported by weight.
[c] See chapters on feldspar and silica.
[d] Includes rottenstone and for 1921 an estimate for part of the diatomaceous earth.

Value of millstones produced and sold in the United States, 1920–1922.

State.	1920	1921	1922
Alabama	(a)	(a)	(a)
Maryland	(a)		
New Hampshire		(a)	
New York	$13,331	$14,672	$17,025
North Carolina	14,226	(a)	(a)
Virginia	34,676	(a)	(a)
Undistributed	1,092	9,852	3,828
	63,325	24,524	20,853

[a] Included under "Undistributed."

Grindstones and pulpstones produced and sold in the United States, 1920–1922.

Year.	Grindstones.			Pulpstones.		
	State.	Short tons.	Value.	State.	Pieces.	Value.
1920	Michigan, Ohio, and West Virginia.	44,832	$1,239,990	Ohio and West Virginia.	2,321	$467,014
1921	do	16,310	477,259	do	2,941	750,063
1922	do	21,367	574,900	do	1,619	445,286

Tripoli produced and sold in the United States, 1921–22.

State.	1921			1922		
	Short tons.	Value.		Short tons.	Value.	
		Crude (estimated.)	As sold (crude and finished).		Crude (estimated).	As sold (crude and finished).
Illinois	7,765	$27,333	$125,352	18,747	$54,741	$194,371
Missouri, Oklahoma, and Pennsylvania[a]	4,575	26,559	87,661	11,458	50,568	122,357
	12,340	53,892	213,013	30,205	105,309	316,728

[a] The Pennsylvania product is sold as "rottenstone." It is essentially a very fine grained argillaceous material and is quite different from tripoli in composition, but its uses are the same.

Diatomaceous earth produced and sold in the United States, 1919–1922.

Year.	Short tons.	Value.	Year	Short tons.	Value.
1919	42,642	$531,960	1921	[a] 55,134	[a] $682,616
1920	61,922	1,079,693	1922	44,761	386,669

[a] Partly estimated.

CONSUMPTION.

Value of abrasive materials [a] available for consumption in the United States, 1919–1922.

	1919	1920	1921	1922
Natural abrasives produced and sold	$2,887,902	$4,299,812	$2,756,614	$2,732,674
Artificial abrasives produced and sold	7,465,849	7,492,164	1,996,147	5,317,485
Imports	2,237,077	4,425,409	1,177,400	1,695,402
	12,590,828	16,217,385	5,930,161	9,745,561
Exports	6,138,366	7,025,621	3,320,590	1,217,615
Apparent consumption	6,452,462	9,191,764	2,609,571	8,527,946

[a] Exclusive of feldspar and various forms of quartz. See chapters on feldspar and silica.

IMPORTS AND EXPORTS.

Value of abrasive materials imported for consumption in the United States, 1919–1922.

Material.	1919	1920	1921	1922
Millstones and burrstones	$26,356	$20,954	$13,556	$15,356
Grindstones and pulpstones	50,551	77,046	81,880	81,733
Hones, oilstones, and whetstones	12,199	56,416	36,761	48,938
Emery and corundum	595,203	617,187	393,454	389,390
Diatomaceous earth, tripoli, and rottenstone	12,545	16,323	13,203	10,429
Pumice	119,781	249,995	173,201	118,458
Diamond dust and bort	1,420,442	3,387,488	466,345	1,029,261
Garnet	(a)	(a)	(a)	[a] 1,837
	2,237,077	4,425,409	1,177,400	1,695,402

[a] Not separately classified prior to new tariff, Sept. 22, 1922.

Value of burrstones and millstones imported for consumption in the United States, 1919–1922.

Year.	Rough.	Made into millstones.	Total.	Year.	Rough.	Made into millstones.	Total.
1919	$8,996	$17,360	$26,356	1921	$3,075	$10,481	$13,556
1920	9,007	11,947	20,954	1922	7,412	7,944	15,356

Emery and corundum imported for consumption in the United States, 1920–1922.

Year.	Grains.		Ore and rock.		Other manufactures.	Total value.
	Pounds.	Value.	Long tons.	Value.		
1920	1,766,554	$85,966	8,226	$519,839	$11,382	$617,187
1921	1,504,971	82,771	6,169	281,931	28,752	393,454
1922	381,222	16,643	5,297	329,902	42,845	389,390

Value of general imports of pebbles and flint into the United States, 1920–1922.

Country.	1920	1921	1922
Belgium	$65,097	$23,404	$15,460
Canada	430	1,510	920
Denmark	131,028	36,924	51,076
England			8
France	131,950	54,248	73,636
Germany	9,528	53	2,932
Mexico	30		
Netherlands	567		681
Norway			421
Poland and Danzig			671
Scotland		18	
	338,630	116,157	145,805

Value of domestic abrasive materials exported from the United States, 1920–1922.

Material.	1920	1921	1922
Grindstones	$424,322	$281,976	$281,413
Abrasive wheels, emery, and other	2,791,128	1,318,804	644,151
All other	3,810,171	1,719,810	292,051
	7,025,621	3,320,590	1,217,615

ARTIFICIAL ABRASIVES.

The artificial abrasives here considered are of three kinds—(1) metallic abrasives, manufactured by the Pittsburgh Crushed Steel Co., Pittsburgh, Pa., and the Globe Iron-Crush & Shot Co., Mansfield, Ohio; (2) silicon carbides, manufactured by the Carborundum Co. at Niagara Falls, N. Y., the Norton Co. at Chippewa, Ontario, and the Exolon Co. at Thorold, Ontario, and Blasdell, N. Y.; (3) aluminum oxides, manufactured by the Norton Co. at Niagara Falls, N. Y., and Chippewa, Ontario, the Carborundum Co. at Niagara Falls, N. Y., Niagara Falls, Ontario, and Shawinigan Falls, Quebec, the Exolon Co. at Blasdell, N. Y., and Thorold, Ontario, the General Abrasives Co. (Inc.) at Niagara Falls, N. Y., the Abrasive Co. of Canada at Hamilton, Ontario, and the National Abrasive Co. at Hamilton, Ontario.

Artificial abrasives produced and sold in the United States and Canada, 1919–1922.

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1919	101,036,000	$7,465,849	1921	26,398,000	$1,996,147
1920	84,874,000	7,492,164	1922	107,870,000	5,690,475

CEMENT.

By E. F. Burchard and B. W. Bagley.

GENERAL REVIEW.

The final returns of the output of Portland cement in 1922, published April 18, 1923, showed that the total production was nearly 115,000,000 barrels and the total shipments nearly 118,000,000 barrels, both new high records.

Since June, 1921, the United States Geological Survey has been compiling and publishing, in cooperation with the Portland Cement Association, monthly statistics of production, shipments, and stocks of Portland cement. These figures have been made public before the middle of the following month, and the reports for December, 1921 and 1922, gave a relatively early summary of the approximate totals for each year. These totals proved to be slightly lower than the final returns in each year.

As the cement industry was not reviewed in Mineral Resources for 1921, it may be well to outline briefly conditions during that year as well as 1922. In the last two months of 1920 there was a decline in the demand for cement when building activity slackened, and this decline continued through January, 1921, but the demand rose during the spring and summer, bringing production up to the maximum for the year in October, from which there were declines again until February, 1922. The production and shipments in 1921 failed to reach the record of 1920 by about 1 per cent, owing to various influences. In the Middle West and Rocky Mountain States loss of business was ascribed to the low prices received by the farmer for his products; on the Atlantic and Pacific coasts and in large cities throughout the country, except in southern California, the irregularity of the building program prevented free expansion in the cement industry. In 1921 there was not so much general complaint as in other recent years regarding labor and transportation conditions, and many plants were enabled to maintain about the same degree of activity as in the preceding year by the local increase in the use of cement concrete for road building.

The year 1922 began with production and shipments of Portland cement at about the same level as at the beginning of 1921 but with much larger stocks. From February until May the cement made and shipped increased at a much more rapid rate than in 1921 and the high points in August and October were well above those in 1921. From manufacturers' comments on trade conditions in 1922 it is evident that many mills that found demand strong might have made and shipped more cement than they actually did, their handicaps

being shortages of cars and of coal, both of which were directly attributable to strikes. Higher prices for coal made manufacturing costs higher, but average selling prices in 1922 decreased about 7 per cent, following a 6 per cent decrease in 1921, making a total reduction from the price of 1920, which held the recent record, of 26 cents a barrel, and this reduction in cement prices may have played an important part in encouraging the active resumption of building. In most parts of the country there was more building than in 1921, and cement mills in Kansas, Ohio, Tennessee, Texas, and Washington attribute to increased road work a good deal of the enlarged demand. In the northern Rocky Mountain States conditions seemed to be least satisfactory in 1922, mills in most of the other States having reported trade as good as in 1921 or better. Stocks were reduced at the end of 1922, but they were higher than at the end of 1920 and represented a safe reserve.

One of the features of the year 1922 was the commemoration in November of the twentieth anniversary of the Portland Cement Association. The Geological Survey has since 1910 enjoyed helpful cooperation in statistical and scientific studies from this association, and a few facts concerning its growth and work will be of interest. It began in 1902, when a group of about 20 cement manufacturers met in Philadelphia to consider the cement-sack problem. Within a year common interests drew into the organization producers of 90 per cent of the output of Portland cement in the United States, and at present more than 95 per cent of the domestic output is represented by membership in the association, which now extends also to manufacturers in Canada, Mexico, Cuba, Argentina, and Uruguay. From a single paid employee in 1902–1905 the staff of the association has grown into one of the largest engineering, educational, and scientific research organizations in the world and at the end of 1922 comprised 342 employees, more than 200 of whom were trained engineers. Twenty-four district offices are maintained, one of them in Canada, for the purpose of rendering to the public free the utmost service and advice concerning the economical and efficient utilization of cement and concrete. A structural-materials research laboratory is maintained at Lewis Institute, Chicago, which has carried its investigations far beyond those possible to Government laboratories at the present time. The Portland Cement Association is doing work of so many kinds that to enumerate them in detail here would require too much space, but it is rendering so broad a service to the public that a brief outline of its activities and publications may well be furnished by the Geological Survey, which has occasion continually to refer correspondents to the association for data that are commonly believed to be obtained by the Government.

The general subjects of papers distributed by the Portland Cement Association during 1922 included various phases of concrete roads, streets, alleys, pavements, bridges, schoolhouses, homes, swimming pools, mercantile and industrial buildings, fireproof buildings, chimneys, garages, coal pockets, grain tanks, railway-track supports, oil tanks, drainage tile, sewer pipe, silos, manure tanks, septic tanks, foundations, concrete block and brick, fence posts, making and use of concrete, storage of cement, and many miscellaneous subjects. It also issued periodical publications devoted to highways and construction.

L. T. Sunderland,[1] of Kansas City, Mo., president of the Portland Cement Association in 1921–22, has broadly defined the aims of the association to be to increase the knowledge, utility, and use of Portland cement through scientific investigation and public education; and to sell the "use of cement" but not the commodity, and hence not to concern itself with prices nor trade relationships, nor as to what brand of cement is used, provided it comes from mills of members the quality of whose product is known to be beyond reproach. One requirement for membership in the association is that the product shall meet accepted engineering standards, which correspond to the United States Government specification for Portland cement.[2] Outstanding features of the association's recent work within the industry have been accident and fire prevention and conservation. Fire prevention throughout the field of construction has been furthered by the association's activity in stimulating the use of concrete in building.

A few side lights on the magnitude of the cement industry are afforded by its consumption of certain raw materials. In coal consumption the industry is reported to occupy fourth place among American coal-using manufactories in 1921, with a consumption of 7,400,000 tons. It also used 2,300,000 barrels of crude oil and 3,000,000,000 cubic feet of natural gas. In the same year the industry used 14,000,000 pounds of dynamite for blasting. The raw materials, limestone, shale, slag, etc., exclusive of fuel and explosives, amounted to about 30,000,000 tons, an average of more than 600 pounds to the barrel of cement (376 pounds). For the shipment of a large part of the output of finished cement, 30,000,000 new sacks are estimated to be required annually; this quantity of sacks represents the combined operation of 1,600 looms every day for a year and the material from 15,000,000 pounds of baled cotton. The cloth that goes into these sacks if woven in one piece 30 inches wide would be 17,000 miles long. It is estimated that the total investment in the Portland cement industry is about $300,000,000, the total number of employees more than 36,000, and the annual pay roll more than $60,500,000.[3]

A summary of values of buildings represented by permits issued during 1919–1922 in 178 cities representing all parts of the United States is presented in the following table to illustrate the general trend of building construction during these years. These values tabulated in detail, by cities, were compiled by the Portland Cement Association from Bradstreet's and American Contractor Building Statistics. During the four years decreases in the totals for the several groups of cities occurred mainly in 1920, and there were general increases in all groups in 1922.

In a second table is shown a summary of values of contracts awarded for buildings of all classes and for engineering construction work of all other kinds, including roads, streets, sewers, and bridges, in States north of Ohio River and east of Missouri River, as compiled by F. W. Dodge Co. and published in more detail by the Portland Cement Association. This table shows decreases in the totals of

[1] Progress review of twenty years, Chicago, Portland Cement Assoc., 1922.
[2] United States Government specification for Portland cement: U. S. Dept. Commerce Bur. Standards Circ. 33, 3d ed., 1917. See also Cement in 1916: U. S. Geol. Survey Mineral Resources 1916, pt. 2, pp. 363–365, 1918.
[3] Sunderland, L. T., Fifty years of Portland cement in America: Philadelphia Record, Jan. 8, 1923.

certain States for both 1920 and 1921 and one decrease in 1922, but the general increase of 42 per cent in 1922 approaches that of 53 per cent for buildings alone in that year.

Values of building permits issued in 178 cities in the United States, 1919–1922.

Group of cities.	1919	1920	1921	1922	Increase in 1922 (per cent).
New England	$87,322,000	$100,449,000	$84,907,000	$153,680,000	81
Southern, east of Mississippi River	69,034,000	75,753,000	86,995,000	140,525,000	62
Middle Atlantic	240,360,000	263,921,000	274,075,000	472,472,000	72
New York City	260,361,000	276,150,000	444,033,000	601,883,000	36
Middle western	454,959,000	423,421,000	439,196,000	696,482,000	59
Southern, west of Mississippi River	11,518,000	22,947,000	16,505,000	21,954,000	33
Northwestern	44,569,000	39,956,000	45,311,000	65,671,000	45
Southwestern	59,262,000	55,482,000	56,696,000	64,545,000	14
Rocky Mountain	14,082,000	13,357,000	16,327,000	25,911,000	59
Pacific coast	102,903,000	168,927,000	201,989,000	302,150,000	50
	1,344,370,000	1,440,363,000	1,666,035,000	2,545,273,000	53

Values of contracts awarded for buildings and all other construction work in States north of Ohio River and east of Missouri River, 1919–1922.

States.	1919	1920	1921	1922	Increase or decrease, 1922 (per cent).
New England	$238,905,000	$306,935,000	$205,147,000	$333,572,000	+62
New York and northern New Jersey	543,435,000	605,336,000	645,803,000	893,250,000	+38
Eastern Pennsylvania, southern New Jersey, Maryland, Delaware, District of Columbia, Virginia, North Carolina, and South Carolina	394,821,000	300,812,000	355,235,000	488,942,000	+38
Western Pennsylvania, West Virginia, Ohio, Kentucky, and Tennessee	440,010,000	461,502,000	420,549,000	580,748,000	+38
Illinois, Indiana, Iowa, Wisconsin, Michigan, Missouri, parts of eastern Kansas and Nebraska	887,369,000	797,485,000	643,994,000	970,874,000	+51
Minnesota, North Dakota, and South Dakota	75,400,000	92,453,000	85,262,000	78,564,000	−8
	2,579,880,000	2,564,523,000	2,355,990,000	3,345,950,000	+42

PRINCIPAL HYDRAULIC CEMENTS.

The Portland and other (masonry, natural, and puzzolan) cements shipped from the mills in the United States in 1922 increased 23 per cent in quantity and 15 per cent in value over the shipments in 1921.

Hydraulic cements shipped from factories in the United States in 1920–1922.

Class.	1920		1921		1922	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value
Portland	96,311,719	$194,439,025	95,507,147	$180,778,415	117,701,216	$207,170,430
Masonry, natural, and puzzolan	767,481	1,150,890	539,402	897,025	889,428	1,293,598
	97,079,200	195,589,915	96,046,549	181,675,440	118,590,644	208,464,028

PORTLAND CEMENT.

PRODUCTION, SHIPMENTS, AND STOCKS.

The total production of Portland cement in the United States in 1922, as reported to the United States Geological Survey, showed an increase of 16 per cent over that of 1921. The shipments from the mills showed increases of 23 per cent in quantity and nearly 15 per cent in gross value. The average selling price at the mills decreased 13 cents a barrel, or nearly 7 per cent.

The statistics in the following table are arranged by States, so far as possible. The term "producing plant" or "active plant" as used for many years in these reports is applied to a mill or group of mills located at one place and operated by one company, but each establishment at a different place is counted as a plant.

In the table by districts statistics are given for groups of States, generally not more than three, or parts of States, that are geographically and commercially related.

Of the 27 States in which Portland cement was manufactured in 1922, all but 5 showed an increase in production and all but 3 showed an increase in shipments, as compared with 1921. All the commercial districts showed increases in both production and shipments, the gains in production ranging from 6 to 36 per cent and in shipments from 12 to 48 per cent. The net change for the whole country was an increase of 16 per cent in production and of 23 per cent in shipments. In 1922 shipments exceeded production by 2,911,232 barrels.

Portland cement produced, shipped, and in stock in the United States, 1921 and 1922, by States.

State.	Production.					Shipments.							Stock.		
	Active plants.		Barrels.		Increase or decrease, 1922 (per cent).	1921		1922		Average factory price per barrel.		Increase in quantity, 1922 (per cent).	Barrels.		Increase or decrease, 1922 (per cent).
	1921	1922	1921	1922		Barrels.	Value.	Barrels.	Value.	1921	1922		1921 (revised).	1922	
Alabama	3	3	1,743,287	2,290,884	+31	1,714,286	$3,466,223	2,324,116	$4,135,684	$2.02	$1.78	36	68,638	35,406	−48
California	9	9	7,302,784	8,711,515	+19	7,180,700	16,856,258	9,041,788	20,478,577	2.35	2.26	26	564,713	235,441	−58
Illinois	4	4	5,587,825	6,407,129	+15	5,237,510	9,092,982	6,554,945	10,584,171	1.74	1.61	25	772,955	625,139	−19
Iowa	4	4	4,590,920	4,272,432	−7	4,151,439	7,439,983	4,475,074	7,709,313	1.79	1.72	8	993,090	790,447	−20
Kansas	7	7	3,781,494	4,634,287	+23	3,643,582	7,253,944	4,556,517	8,138,268	1.99	1.79	25	540,877	618,647	+14
Michigan	11	12	5,777,533	6,243,805	+8	5,680,156	10,300,289	6,349,751	11,145,573	1.81	1.76	12	759,703	641,432	−16
Missouri	5	5	4,446,091	6,170,633	+39	4,375,712	8,034,540	6,239,144	10,457,557	1.84	1.68	43	640,932	572,444	−11
New York	8	9	5,294,188	5,922,706	+12	4,993,341	9,403,015	6,194,663	10,694,426	1.88	1.73	24	784,607	516,365	−34
Ohio	5	5	2,563,773	2,835,243	+11	2,518,723	4,615,492	2,913,034	5,243,687	1.83	1.80	16	238,678	161,797	−32
Pennsylvania	22	22	27,628,598	33,276,093	+20	26,622,367	46,881,625	34,023,695	55,528,002	1.76	1.63	28	3,410,698	2,659,452	−22
Texas	5	5	2,668,741	3,628,756	+36	2,514,045	5,902,863	3,730,477	7,515,932	2.35	2.01	48	296,296	190,762	−36
Washington	4	4	1,678,863	1,942,781	+16	1,612,891	4,080,785	1,951,414	4,684,624	2.53	2.40	21	255,293	246,660	−3
Other States[a]	28	29	25,777,952	28,453,720	+10	25,262,395	47,450,416	29,346,598	50,854,616	1.88	1.73	16	2,866,087	1,973,246	−31
	115	118	98,842,049	114,789,984	+16	95,507,147	180,778,415	117,701,216	207,170,430	1.89	1.76	23	12,192,567	9,267,238	−24

[a] Colorado, Georgia, Indiana, Kentucky, Maryland, Minnesota ,Montana ,Nebraska, New Jersey, Oklahoma, Oregon, Tennessee, Utah, Virginia, and West Virginia.

Portland cement produced, shipped, and in stock in the United States, 1921 and 1922, by districts.

Commercial district.	Production.					Shipments.							Stock.		
	Active plants.		Barrels.		Increase, 1922 (per cent).	1921		1922		Average factory price per barrel.		Increase in quantity, 1922 (per cent).	Barrels.		Increase or decrease, 1922 (per cent).
	1921	1922	1921	1922		Barrels.	Value.	Barrels.	Value.	1921	1922		1921 (revised).	1922	
Eastern Pennsylvania, New Jersey, and Maryland	22	22	25,571,726	31,195,617	22	24,841,973	$44,110,573	31,897,649	$51,953,144	$1.78	$1.63	28	2,998,155	2,294,497	−23
New York	8	9	5,294,188	5,922,706	12	4,993,341	9,403,015	6,194,663	10,694,426	1.88	1.73	24	784,607	516,365	−34
Ohio, western Pennsylvania, and West Virginia	10	10	9,501,895	10,753,301	13	9,185,858	15,947,184	11,040,908	18,586,754	1.74	1.68	20	1,151,043	862,361	−25
Michigan	11	12	5,777,533	6,243,805	8	5,680,156	10,300,289	6,349,751	11,145,573	1.81	1.76	12	759,703	641,432	−16
Illinois, Indiana, and Kentucky	10	10	17,050,741	17,998,914	6	16,423,356	28,468,092	18,676,656	30,159,728	1.73	1.61	14	2,102,438	1,424,696	−32
Virginia, Tennessee, Alabama, and Georgia	7	8	5,065,854	5,954,043	18	4,916,245	9,879,466	6,158,652	10,854,347	2.01	1.76	25	374,105	169,506	−55
Eastern Missouri, Iowa, and Minnesota	9	9	9,951,283	11,392,552	15	9,432,573	16,805,272	11,657,484	19,528,016	1.78	1.68	24	1,717,321	1,452,387	−15
Western Missouri, Nebraska, Kansas, and Oklahoma	11	11	6,351,747	8,025,720	26	6,100,391	12,503,617	7,967,266	14,570,823	2.05	1.83	31	877,640	936,118	+7
Texas	5	5	2,668,741	3,628,756	36	2,514,045	5,902,863	3,730,477	7,515,932	2.35	2.01	48	296,206	190,762	−36
Colorado and Utah	5	5	1,860,573	2,020,784	9	1,806,931	4,330,333	2,063,500	4,609,605	2.40	2.23	14	215,579	172,857	−20
California	9	9	7,302,784	8,711,515	19	7,180,700	16,856,258	9,041,788	20,478,577	2.35	2.26	26	564,713	235,441	−58
Oregon, Washington, and Montana	8	8	2,444,984	2,942,271	20	2,431,578	6,271,453	2,922,422	7,073,505	2.58	2.42	20	350,967	370,816	+6
	115	118	98,842,049	114,789,984	16	95,507,147	180,778,415	117,701,216	207,170,430	1.89	1.76	23	12,192,567	9,267,238	−24

The following table shows production, shipments, and stocks by months for 1921 and 1922. The statistics for 1921 are compiled from information furnished in part by the Portland Cement Association. Although the figures are not quite complete and therefore only approximate the totals shown in other tables of this report that are based on final annual returns from the producers, they reflect the fluctuations in the industry during the year. Production of Portland cement is necessarily curtailed to some extent in December, January, and February in the colder parts of the United States at plants using marl as a raw material and at other plants where the wet process is employed, and numerous other mills also close for repairs in the winter, when the demand is least strong. Movements are now on foot, as discussed under "Capacity," to create a steadier demand for cement.

Estimated production, shipments, and mill stocks of Portland cement, by months, in 1921 and 1922, in barrels.

Month.	1921 [a]			1922		
	Production.	Shipments.	Stocks on last day of the month.	Production.	Shipments.	Stocks on last day of the month.
January	4,098,000	2,539,000	10,300,000	4,291,000	2,931,000	13,316,000
February	4,379,000	3,331,000	11,400,000	4,278,000	3,285,000	14,142,000
March	6,763,000	6,221,000	12,000,000	6,685,000	7,002,000	13,848,000
April	8,651,000	7,919,000	12,600,000	9,243,000	8,592,000	14,470,000
May	9,281,000	9,488,000	12,450,000	11,176,000	12,749,000	12,893,000
June	9,296,000	10,577,000	11,150,000	11,245,000	13,470,000	10,718,000
July	9,568,000	10,301,000	10,414,000	11,557,000	13,850,000	8,433,000
August	10,244,000	12,340,000	8,280,000	11,664,000	14,361,000	5,746,000
September	10,027,000	11,329,000	6,953,000	11,424,000	12,444,000	4,724,000
October	10,506,000	12,114,000	5,348,000	12,287,000	12,854,000	4,149,000
November	8,921,000	5,195,000	9,091,000	11,349,000	10,167,000	5,320,000
December	6,559,000	3,697,000	11,938,000	8,671,000	4,858,000	9,267,000

[a] Based in part on statistics compiled by the Portland Cement Association.

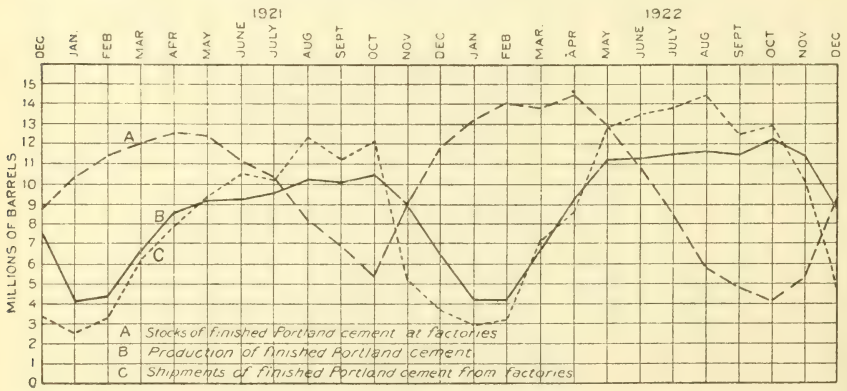

FIGURE 4.—Monthly fluctuations in production, shipments, and stocks of finished Portland cement, 1921 and 1922.

Portland cement shipped from mills in the United States, 1917–1922.

Year.	Barrels.	Value.	Year.	Barrels.	Value.
1917	90,703,474	$122,775,088	1920	96,311,719	$194,439,025
1918	70,915,508	113,316,275	1921	95,507,147	180,778,415
1919	85,612,899	146,734,844	1922	117,701,216	207,170,430

The stock of Portland cement reported on hand at the mills at the end of 1922 showed a decrease of 24 per cent from the unusually large stock of 1921 and was not quite equal to the average for the last six years (9,392,442 barrels). The reports of stocks at a few mills in 1921 were revised by the producers. The totals by States and districts are shown in preceding tables.

Finished Portland cement in stock in the United States, December 31, 1917 to 1922.

	Barrels.		Barrels.
1917	10,353,838	1920	8,833,067
1918	10,451,044	1921	12,192,567
1919	5,256,900	1922	9,267,238

DOMESTIC CONSUMPTION.

An estimate of the total consumption of Portland cement in the United States may be made by adding the imports to the shipments and subtracting the exports from the sum. Of course a variable but considerable stock of cement is at all times in transit, in warehouses at distributing points, and awaiting use at jobs, so that the estimate thus made is at best only approximate. Still another uncertain element in this estimate is the fact that as the cement imported and exported is classed as hydraulic cement the records do not discriminate between Portland and other cements and probably also include some plaster. Portland cement, however, constitutes by far the greater part of the exports, and, as the tables show, the imports are small. The apparent domestic consumption in 1922 showed an increase of nearly 24 per cent, as compared with the consumption in 1921.

Portland cement available for domestic consumption, 1917–1922, in barrels.

Year.	Shipments.	Imports.	Exports.	Available for consumption.
1917	90,703,474	2,323	2,586,215	88,119,582
1918	70,915,508	305	2,252,446	68,663,367
1919	85,612,899	8,931	2,463,573	83,158,257
1920	96,311,719	524,604	2,985,807	93,850,516
1921	95,507,147	122,322	1,181,014	94,448,455
1922	117,701,216	323,823	1,127,845	116,897,194

The estimates of consumption of Portland cement are of course only approximate, as they represent only the records of shipments by manufacturers into the several States. The shipments of cement into a State during a year may not equal the consumption in that State during the same year, but shipments for a long period should afford a very fair index to the consumption.[4] The simplest available common unit is the estimated consumption per capita in barrels, which is obtained by comparing the shipments into States with the population for the States in 1921 and 1922. The estimates of population in the following table were furnished by the Bureau of the Census.

There is a difference between the official figures of the Bureau of Foreign and Domestic Commerce for exports of cement, as given on page 248, and the exports reported by manufacturers, as given in the

[4] Data on per capita consumption of Portland cement by States beginning with the year 1914 are given in preceding volumes of Mineral Resources.

following table, owing to the fact that cement shipped from mills destined for foreign countries and to Alaska, Hawaii, and Porto Rico is reported by the shipper as exported, whether or not it leaves the country during that calendar year, but the Bureau of Foreign and Domestic Commerce bases its export figures on the cement that actually leaves the country, according to its records. (The shipments to Alaska, Hawaii, and Porto Rico, are given on p. 247.) The exports given by the bureau for 1921 include all other hydraulic cement exported, whereas the table of per capita consumption relates only to Portland cement, but in 1922 Portland and natural cements are given separately.

The per capita consumption shown by the table necessarily falls short of the total apparent consumption by the quantity of the imports. These, however, are not great and increase the consumption only in certain States near the Canadian border and in those having seaports; in 1922 they increased the general average per capita consumption by less than 0.003 barrel.

The highest per capita consumption in 1922 was that of California, 2.23 barrels. Although this State also held the record in 1921, 1.69 barrels, it showed the largest increase in 1922. There were 22 States in which the per capita consumption in 1922 was 1 barrel or more, 11 of them east and 11 of them west of Mississippi River; none of them were in the South. Changes occurred in all the States except Utah, and only four decreases were recorded. The general average consumption was 1.06 barrels, compared with 0.87 barrel in 1921. This is the highest average per capita consumption for the United States on record, the range hitherto since 1914 having been from 0.64 to 0.89 barrel.

Estimated per capita consumption of Portland cement in the United States in 1921 and 1922.

State.	1921			1922		
	Population (estimated as of Jan. 1, 1922).[a]	Consumption (shipments to States), in barrels.		Population (estimated as of Jan. 1, 1923).[a]	Consumption (shipments to States), in barrels.	
		Total.	Per capita.		Total.	Per capita.
Alabama	2,391,453	604,535	0.25	2,413,092	998,009	0.41
Arizona[b]	360,903	514,919	1.43	374,274	633,999	1.69
Arkansas[b]	1,788,823	604,554	.34	1,807,132	498,075	.28
California	3,643,028	6,173,132	1.69	3,751,111	8,356,362	2.23
Colorado	968,595	802,718	.83	983,078	1,093,026	1.11
Connecticut[b]	1,435,404	1,044,174	.73	1,462,790	1,262,018	.86
Delaware[b]	227,264	313,344	1.38	229,394	353,201	1.54
District of Columbia[b]	[c] 437,571	445,578	1.02	[c] 437,571	661,865	1.51
Florida[b]	1,012,937	663,583	.66	1,035,170	924,112	.89
Georgia	2,954,897	881,560	.30	2,984,429	1,084,395	.36
Idaho[b]	453,759	244,945	.54	464,705	257,253	.55
Illinois	6,659,705	6,366,563	.96	6,746,917	9,667,741	1.43
Indiana	2,977,673	3,397,130	1.14	3,001,314	3,894,909	1.30
Iowa	2,440,948	3,118,469	1.28	2,459,411	3,246,436	1.32
Kansas	1,785,390	2,292,363	1.28	1,793,456	2,692,345	1.50
Kentucky	2,442,737	1,010,815	.41	2,455,790	1,163,279	.47
Louisiana[b]	1,827,788	681,538	.37	1,842,427	906,467	.49
Maine[b]	773,297	399,626	.52	775,938	461,749	.60
Maryland	1,481,452	1,394,415	.94	1,497,347	1,547,304	1.03
Massachusetts[b]	3,952,464	2,164,183	.55	4,002,518	3,045,511	.76
Michigan	3,845,217	6,112,986	1.59	3,933,619	6,196,586	1.58
Minnesota	2,451,280	3,090,803	1.26	2,483,357	3,555,842	1.43

[a] Bureau of the Census.
[b] Non cement-producing States.
[c] Population Jan. 1, 1920; no later estimate made.

Estimated per capita consumption of Portland cement in the United States in 1921 and 1922—Continued.

State.	1921			1922		
	Population (estimated as of Jan. 1, 1922).	Consumption (shipments to States), in barrels.		Population (estimated as of Jan. 1, 1923).	Consumption (shipments to States), in barrels.	
		Total.	Per capita.		Total.	Per capita.
Mississippi [b]	[c] 1,790,618	377,657	0.21	[c] 1,790,618	422,591	0.24
Missouri	3,426,864	2,236,368	.65	3,438,268	3,017,859	.88
Montana	584,495	309,165	.53	602,298	265,294	.44
Nebraska	1,317,829	1,050,058	.80	1,328,557	1,606,062	1.21
Nevada [b]	[c] 77,407	84,473	1.09	[c] 77,407	91,646	1.18
New Hampshire [b]	445,660	348,475	.78	446,948	365,210	.82
New Jersey	3,283,365	3,723,051	1.13	3,347,097	5,116,282	1.53
New Mexico [b]	367,159	188,765	.51	370,563	269,351	.73
New York	10,647,190	10,301,525	.97	10,778,171	13,272,157	1.23
North Carolina [b]	2,631,809	1,171,885	.45	2,668,153	2,284,502	.86
North Dakota [b]	661,254	250,180	.38	668,446	284,422	.43
Ohio	5,963,810	6,737,835	1.13	6,066,019	7,770,331	1.28
Oklahoma	2,104,737	1,656,143	.79	2,142,966	2,023,392	.94
Oregon	806,177	824,950	1.02	817,572	943,819	1.15
Pennsylvania	8,937,336	9,268,804	1.04	9,045,997	10,457,809	1.16
Rhode Island [b]	617,125	341,599	.55	623,490	453,950	.73
South Carolina [b]	1,718,400	474,136	.28	1,735,739	628,952	.36
South Dakota [b]	647,395	471,626	.73	652,820	507,084	.78
Tennessee	2,369,423	827,457	.35	2,385,193	939,174	.39
Texas	4,821,172	2,303,573	.48	4,900,145	2,892,922	.59
Utah	465,062	442,863	.95	472,895	450,460	.95
Vermont [b]	[c] 352,428	208,725	.59	[c] 352,428	213,255	.61
Virginia	2,360,189	1,322,447	.56	2,385,690	1,432,326	.60
Washington	1,400,837	1,483,420	1.06	1,422,945	1,750,811	1.23
West Virginia	1,513,675	1,350,384	.89	1,538,662	1,478,476	.96
Wisconsin [b]	2,693,499	3,849,216	1.43	2,724,215	4,584,298	1.68
Wyoming [b]	204,380	286,486	1.40	209,369	228,265	1.09
Unspecified		72,803			55,813	
	[e] 108,540,838	94,286,002	.87	[e] 109,955,947	116,306,997	1.06
Exports reported by manufacturers but not included above [d]		1,221,145			1,394,219	
Total shipped from cement plants		95,507,147			117,701,216	

[b] Non cement-producing State.
[c] Population Jan. 1, 1920; no later estimate made.
[d] Includes shipments to Alaska, Hawaii, and Porto Rico.
[e] Total for continental United States.

The consumption of Portland cement by uses is a subject of public interest. The Geological Survey has had no facilities for collecting detailed statistics on this subject, but engineers of the Portland Cement Association, who are in touch with various industries throughout the country that consume cement, have kindly assisted in making some general rough estimates, and it is believed that the following data will be of service to many readers.

Estimated consumption of Portland cement in 1922, by uses.

	Barrels.
Public and commercial buildings	29,000,000
Dwellings	11,000,000
Sidewalks and private driveways	8,000,000
Miscellaneous farm uses	24,000,000
Concrete pipe for water, sewers, irrigation, and culverts	5,000,000
Paving and highways	28,000,000
Railways	6,000,000
Bridges, river and harbor work, dams and water power projects, storage tanks, and reservoirs	3,500,000
Miscellaneous uses	2,000,000
	116,500,000

LOCAL SUPPLIES.

By comparing the shipments from the mills within a State or group of States with the estimated consumption in the same area it is possible to ascertain the surplus or deficiency in the supply of cement locally available. The following table has been arranged with that end in view, and the consumption in the noncement-producing States is shown in the general table on pages 236–237. Data for 1916 to 1920 will be found in Mineral Resources for 1917 to 1920.

The surplus shown in the following table was distributed, by years, as follows: In 1921, to noncement-producing States, 15,129,667 barrels; to foreign countries (including Alaska, Hawaii, and Porto Rico), 1,221,145 barrels; unspecified, 72,803 barrels; in 1922, to noncement-producing States, 19,337,776 barrels; to foreign countries (including Alaska, Hawaii, and Porto Rico), 1,394,219 barrels; unspecified, 55,813 barrels.

Among the cement-producing States there are, of course, fewer deficiencies than surpluses, and certain of the deficiencies indicated are due to local conditions that did not change materially from 1921 to 1922. For instance, in 1922 Ohio showed a deficiency of more than 4,850,000 barrels, which was largely supplied from Pennsylvania's surplus of more than 23,500,000 barrels, and from Indiana. New York, though a large producer, had a deficiency of more than 7,000,000 barrels, which was mostly supplied from the Lehigh district in Pennsylvania. In Maryland, New Jersey, and West Virginia there was a shortage of more than 2,000,000 barrels, probably supplied in large part from the Lehigh district. The quantities consumed in the nonproducing States are of interest in comparison with the other data. Between 500,000 and 1,000,000 barrels was consumed in 1922 in each of the States of Arizona, Florida, Louisiana, South Carolina, South Dakota, and the District of Columbia. Connecticut consumed more than 1,200,000 barrels, Massachusetts more than 3,000,000 barrels, North Carolina more than 2,200,000 barrels, and Wisconsin more than 4,500,000 barrels.

Estimated surplus or deficiency in local supply of Portland cement in cement-producing States, 1921–1922, in barrels.

State or division.	1921			1922		
	Shipments from mills.	Estimated consumption.	Surplus or deficiency.	Shipments from mills.	Estimated consumption.	Surplus or deficiency.
Alabama	1,714,286	604,535	+ 1,109,751	2,324,116	998,009	+ 1,326,107
California	7,180,700	6,173,132	+ 1,007,568	9,041,788	8,356,362	+ 685,426
Illinois	5,237,510	6,366,563	− 1,129,053	6,551,945	9,667,741	− 3,112,796
Iowa	4,151,439	3,118,469	+ 1,032,970	4,475,074	3,246,436	+ 1,228,638
Kansas	3,643,582	2,292,363	+ 1,351,219	4,556,517	2,692,345	+ 1,864,172
Michigan	5,680,156	6,112,986	− 432,830	6,349,751	6,196,586	+ 153,165
Missouri	4,375,712	2,236,368	+ 2,139,344	6,239,144	3,017,859	+ 3,221,285
New York	4,993,341	10,301,525	− 5,308,184	6,194,663	13,272,157	− 7,077,494
Ohio	2,518,723	6,737,835	− 4,219,112	2,913,034	7,770,331	− 4,857,297
Pennsylvania	26,622,367	9,268,804	+17,353,563	34,023,695	10,457,809	+23,565,886
Texas	2,514,045	2,303,573	+ 210,472	3,730,477	2,892,922	+ 837,555
Colorado and Utah	1,806,931	1,245,581	+ 561,350	2,063,500	1,543,486	+ 520,014
Oregon, Washington, and Montana	2,431,578	2,617,535	− 185,957	2,922,422	2,959,924	− 37,502
Georgia, Kentucky, Tennessee, and Virginia	3,826,659	4,042,279	− 215,620	4,436,003	4,619,174	− 183,171
Indiana, Minnesota, Nebraska, and Oklahoma	13,923,377	9,194,134	+ 4,729,243	15,874,259	11,080,205	+ 4,794,054
Maryland, New Jersey, and West Virginia	4,886,741	6,467,850	− 1,581,109	6,001,828	8,142,062	− 2,140,234
	95,507,147	79,083,532	+16,423,615	117,701,216	96,913,408	+20,787,808

PRICES.

At factories.—Average prices of Portland cement, not including bags, sold at the factories, as reported to the Geological Survey, are shown in the tables of shipments by States and districts during 1921 and 1922. These averages ranged in 1922 from $1.61 a barrel in the Illinois - Indiana - Kentucky district to $2.42 a barrel in the Oregon - Washington - Montana district, as compared with a range from $1.70 a barrel in New Jersey to $2.58 a barrel in the Oregon-Washington-Montana district in 1921. The general average price for the whole country showed a decrease in 1922 of about 7 per cent, and average prices in all the districts and in all the States except West Virginia, where the price remained the same, showed a decrease.

Average factory price per barrel in bulk of Portland cement, 1911–1922.

1911	$0.844	1915	$0.860	1919	$1.71
1912	.813	1916	1.103	1920	2.02
1913	1.005	1917	1.354	1921	1.89
1914	.927	1918	1.598	1922	1.76

At markets.—A summary of wholesale prices, by months, for 1921 and 1922 of Portland cement in bulk in carload lots at the principal cities of the United States and at Montreal, Canada, as published in the Engineering News-Record, is given below. This table is not absolutely consistent, as is indicated in the footnotes, and there are some inconsistencies that are not accounted for by the footnotes, such as sudden large changes in prices. In nearly all cities there was a marked reduction in prices in the early months of 1922 as compared with corresponding periods in 1921, and in most cities prices throughout the first nine months of 1922 remained lower than in 1921, though prices in the fall rose slightly above those of 1921. The net result of the movement of market prices, as with factory prices, was downward, the decreases ranging between 4 and 56 cents a barrel. Los Angeles, Calif., is the only place at which the prices remained practically stationary, and prices here appear to have been the highest of all, probably in part owing to the sustained building activity in southern California throughout 1921 and 1922. Other places at which prices appear to have been higher than would seem to be justified by their location with respect to mills and transportation routes were New Orleans and Baltimore, although at Baltimore an allowance must be made for cost of delivery. As might be expected, the lowest market prices were at cities near which Portland cement is manufactured, such as Duluth, Chicago, Pittsburgh, St. Louis, Birmingham, and Dallas. At these places a large part of the cement used locally is delivered by truck, and naturally the shorter haul should be reflected in a lower price. In New York two scales of prices are quoted, the higher for cement delivered, the lower for cement alongside dock, the difference ranging from 10 to 40 cents a barrel, but this difference does not show any marked influence of foreign cement.

The differences between average factory prices for 1921 and 1922, by districts, and the market prices of cement at the principal cities within the several districts as a rule do not appear to be excessive when all the elements that enter into these differences are taken into consideration. In 1921 they ranged from 30 cents to $1.28 a barrel (the latter including delivery charges) and in 1922 from 35 cents to $1.42 a barrel. In most districts these differences were less than 75 cents a barrel in both years.

Wholesale prices of Portland cement per barrel in bulk in carload lots, 1921–22, by months.[a]

City.	January.		February.		March.		April.		May.		June.	
	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922
Atlanta	$3.00	$2.55	$3.00	$2.69	$3.00	$2.39	$3.00	$2.39	$2.70	$2.39	$2.80	$2.34
Baltimore [b]	2.93	2.50	2.93	2.50	2.93	2.50	3.58	2.50	.....	2.50	3.58	2.50
Birmingham	.....	2.27	.....	2.27	.....	2.27	.....	2.27	.....	2.27	3.05	2.27
Boston	3.41	2.52	3.41	2.50	3.87	2.50	2.87	2.50	2.62	2.50	2.86	2.50
Cedar Rapids	2.71	2.28	2.51	2.26	2.51	2.11	2.51	2.21	2.51	2.21	2.51	2.21
Chicago	2.37	1.97	2.17	1.97	2.17	1.94	2.17	1.97	2.17	1.97	2.17	1.97
Cincinnati	2.77	2.37	2.57	2.35	2.57	2.32	2.57	2.35	2.57	2.35	2.57	2.35
Cleveland	2.73	2.28	2.43	2.26	2.43	2.26	2.43	2.26	2.43	2.26	2.43	2.26
Dallas	3.85	2.55	2.85	2.40	2.85	2.40	2.85	2.25	2.15	2.25	2.60	2.25
Davenport	2.67	2.22	2.47	2.21	2.47	2.06	2.47	2.16	2.47	2.16	2.47	2.14
Denver	3.25	3.10	3.25	2.90	3.10	2.90	3.10	2.90	2.82	2.90	3.10	2.90
Detroit	2.68	2.31	2.51	2.17	2.51	2.17	2.51	2.17	2.43	2.17	2.43	2.17
Duluth	2.35	1.95	2.10	1.95	2.10	1.95	2.10	1.95	2.10	1.94	2.10	1.94
Indianapolis	2.61	2.23	2.31	2.21	2.31	2.21	2.31	2.21	2.43	2.21	2.43	2.21
Jersey City	3.20	2.12	[b]2.89	2.12	[b]2.89	2.12	[b]2.64	2.12	[b]2.67	[b]2.12	[b]2.89	[b]2.32
Kansas City	2.76	2.45	2.76	2.40	2.76	2.40	2.76	2.40	2.56	2.40	2.55	2.40
Los Angeles	3.10	3.31	3.21	3.31	3.21	3.30	3.21	3.30	3.85	3.30	3.21	3.30
Milwaukee	2.59	2.19	2.39	2.18	2.39	2.13	2.39	2.18	2.39	2.18	2.39	2.16
Minneapolis	2.71	2.26	2.41	2.24	2.41	2.24	2.41	2.24	2.41	2.24	2.41	2.24
Montreal	[b][c]3.52	[b]3.10	3.52	[b]3.10	[b]3.50	[b]2.40	3.44	[b]2.50	2.95	[b]2.50	3.44	2.48
New Orleans	4.20	3.20	4.20	3.20	3.60	3.20	3.36	3.00	2.96	3.00	3.36	3.00
New York [b]	3.50	2.30	3.10	{2.20 {2.30	}3.10	2.30	3.10	2.40	3.20	2.40	2.80	{2.40 {2.50
New York (alongside dock to dealers)	.....	2.00	.....	2.00	.....	2.00	2.40	2.30	2.35	2.30	2.40	2.10
Peoria	2.63	2.14	2.43	2.13	2.43	1.98	2.43	2.08	2.45	2.08	2.45	2.08
Philadelphia	.....	2.23	.....	2.21	.....	2.21	.....	2.21	.....	2.21	.....	2.21
Pittsburgh	2.42	2.02	2.17	2.02	2.17	2.02	2.17	2.02	2.17	2.02	2.17	2.02
St. Louis	3.45	2.20	3.45	2.20	3.40	2.20	3.40	2.20	2.80	2.20	2.60	2.20
St. Paul	.....	2.24	.....	2.24	2.41	2.24	2.41	2.24	2.41	2.24	2.41	2.24
San Francisco	3.09	2.84	3.09	2.84	3.09	2.73	3.09	2.73	2.63	2.73	3.09	2.83
Seattle	3.03	3.10	3.10	2.94	3.10	2.94	3.10	2.94	3.03	2.94	3.10	2.94
Toledo	2.71	2.31	2.51	2.20	2.51	2.20	2.51	2.20	2.49	2.20	2.49	2.20

City.	July.		August.		September.		October.		November.		December.	
	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922	1921	1922
Atlanta	$2.60	$2.34	$2.75	$2.50	$2.75	$2.50	$2.69	$2.54	$2.60	$2.54	$2.69	$2.54
Baltimore [b]	3.58	2.50	3.58	2.50	2.98	2.50	2.88	2.90	2.88	2.90	2.88	2.90
Birmingham	3.05	2.10	3.05	2.10	2.85	2.10	2.85	2.40	2.27	2.40	2.27	2.40
Boston	2.86	2.50	2.86	2.50	2.86	.....	2.61	.....	2.61	.....	2.61	2.85
Cedar Rapids	2.51	2.33	2.51	2.33	2.51	2.48	2.28	2.48	2.28	2.45	2.28	2.45
Chicago	2.17	2.05	2.17	2.05	2.17	2.20	1.97	2.20	1.97	2.20	1.97	2.20
Cincinnati	2.57	2.39	2.57	2.39	2.57	2.59	2.37	2.59	2.37	2.51	2.37	2.51
Cleveland	2.43	2.31	2.43	2.31	2.43	2.46	2.28	2.46	2.28	2.46	2.28	2.46
Dallas	2.60	2.25	2.60	2.25	2.80	2.25	2.55	2.25	2.55	2.25	2.55	2.25
Davenport	2.47	2.28	2.47	2.28	2.47	2.43	2.22	2.43	2.22	2.43	2.22	2.43
Denver	3.10	2.90	3.10	2.85	3.10	2.85	3.10	2.85	3.10	2.85	3.10	2.85
Detroit	2.43	2.33	2.43	2.33	2.43	2.48	2.31	2.48	2.31	2.48	2.31	2.47
Duluth	2.10	2.02	2.10	2.14	2.10	2.14	1.95	2.14	1.95	2.14	1.95	2.14
Indianapolis	2.43	2.26	2.43	2.26	2.43	2.41	2.23	2.41	2.23	2.41	2.23	2.41
Jersey City	[b]2.89	[b]2.28	[b]2.89	[b]2.28	2.89	2.73	2.60	2.73	2.28	2.73	2.13	2.48
Kansas City	3.20	2.40	3.20	2.40	3.05	2.85	2.80	2.85	2.45	2.85	2.45	2.45
Los Angeles	3.31	3.30	3.21	3.30	3.31	3.30	3.31	3.30	3.31	.....	3.31	.....
Milwaukee	2.39	2.22	2.39	2.22	2.39	2.37	2.19	2.37	2.19	2.37	2.19	2.37
Minneapolis	2.41	2.29	2.41	2.39	2.41	2.39	2.26	2.39	2.26	2.39	2.26	2.39
Montreal	.....	2.88	2.75	2.78	2.75	2.78	2.75	2.78	3.10	2.88	[b]3.12	2.88
New Orleans	3.36	3.20	3.20	3.20	3.20	3.20	3.20	3.30	2.88	3.30	2.88	3.30
New York [b]	2.80	{2.40 {2.50	2.60 2.70	2.45 2.50	2.60 2.70	}2.60	2.50	{2.60 {2.75	}2.40	2.60	2.40	2.60
New York (alongside dock to dealers)	2.40	2.10	2.10	2.10	2.40	2.30	2.10	2.55	2.10	2.30	2.10	2.30
Peoria	2.45	2.26	2.45	2.26	2.45	2.41	2.14	2.41	2.14	2.39	2.14	2.39
Philadelphia	.....	2.31	.....	2.31	.....	2.41	.....	2.41	.....	2.51	2.50	2.51
Pittsburgh	2.17	2.09	2.17	2.09	2.17	2.24	2.02	2.24	2.02	2.24	2.02	2.24
St. Louis	3.00	2.20	2.90	2.20	2.90	2.20	2.90	2.35	2.25	2.35	1.97	2.35
St. Paul	2.41	2.29	2.41	2.39	2.41	2.39	2.26	2.39	2.26	2.39	2.26	2.39
San Francisco	3.09	2.63	3.09	2.71	3.09	2.71	2.84	2.71	2.84	2.71	2.84	2.71
Seattle	3.10	2.90	3.10	2.90	3.10	2.90	3.10	2.90	3.10	2.90	3.10	2.90
Toledo	2.49	2.33	2.49	2.33	2.49	2.53	2.31	2.53	2.31	2.48	2.31	2.48

[a] Prices quoted are f. o. b. points listed without bags unless otherwise designated—cash discount not deducted.

[b] Delivered.

[c] Includes bags. Bag charge is quoted as 10 cents each, 40 cents a barrel; sometimes quoted as 20 cents each in Canada.

According to a recent article,[5]

A comparison between the price of cement and that of other building materials indicates that the price of cement did not rise to the high point reached by other building materials. * * * Let us compare to-day's price of the essential elements in the cost of cement with the price in 1914: Coal per ton delivered at the cement mill in 1914 cost $2.45. Coal now costs $6 per ton. Labor in cement plants in 1914 received on the average 20.1 cents an hour and now receives an average rate of about 42 cents an hour. Gypsum per ton at plant in 1914 cost $2.75. It now costs $6.20 per ton. Bags per 1,000 in 1914 cost about $82. Now bags cost about $215 per 1,000 due to the rise in the price of cotton from 7 cents a pound in 1914 to about 30 cents a pound to-day, and it takes four bags to make a barrel of cement.

Selling expense is also an important item in the cost of cement. Nineteen eastern companies report that selling expenses increased on the average from 6.4 cents per barrel in 1914 to 12.5 cents per barrel in 1921. When existing conditions are taken into consideration present figures for cement compare very well with those prevailing in 1915.

MANUFACTURING CONDITIONS.

PLANTS.

Portland cement was manufactured at 118 plants in 1922, as compared with 115 plants in 1921. Three plants that were idle during 1921 or longer produced Portland cement in 1922—the branch of the Wolverine Portland Cement Co. at Quincy, Mich.; the plant of the Hudson Valley Portland Cement Corporation at Alsen, Greene County, N. Y.; and the plant of the Georgia Cement & Stone Co. at Portland, Polk County, Ga. The last two plants belong to companies that have been reorganized and are equipped as follows: Plant at Alsen, dry process, limestone and shale, clinker burned with coal, two 125 by 8 foot kilns, daily clinker capacity 1,500 barrels; plant at Portland, dry process, limestone and shale, one 125 by 8 foot kiln, daily clinker capacity 750 barrels.

New plants were under construction in 1922 in Alabama, Iowa, Michigan, Ohio, and Tennessee, and it is expected that several of these plants will report production in 1923.

KILNS AND FUELS.

The total number of rotary kilns reported in plants that operated in 1922 was 760, compared with 740 in 1921. Recent studies by conservation engineers have indicated that the diameter of rotary kilns should be considered as well as the length. Some of these studies are reported to have shown that an increase in the diameter of the lower end of the kiln has resulted in an increase in the output of clinker.

Number of rotary cement kilns of different lengths in active plants in the United States, 1919–1922.

Length (feet).	Number of kilns.				Length (feet).	Number of kilns.			
	1919	1920	1921	1922		1919	1920	1921	1922
40 to 60	71	74	74	78	126 to 149	63	63	64	66
61 to 99	87	87	87	91	150 to 199	66	73	76	75
100 to 109	98	98	91	102	200 to 260	19	23	29	31
110	55	66	56	54					
120	95	97	99	101		720	753	740	760
125	166	172	164	162					

[5] Comparison made on prices of cement: Chem. and Met. Eng., Mar. 21, 1923, p. 536.

As to kiln fuels the records of 1922 are noteworthy in showing that only 75.7 per cent of the Portland cement produced was burned with coal alone, a decrease from 81.5 per cent in 1921. Records from 1907 to 1921 show that the percentages of cement burned with powdered coal ranged from 81.2 in 1920 to 88.5 in 1907 and ran generally about 82 per cent. Increased consumption of crude oil and natural gas, due to the greater abundance of crude oil for fuel in 1922, accounts for the difference.

Portland cement burned by different fuels in 1921 and 1922.

Fuel.	1921				1922			
	Number of plants.	Number of kilns.	Barrels of cement.	Percentage of total.	Number of plants.	Number of kilns.	Barrels of cement.	Percentage of total.
Coal	92	607	80,557,675	81.5	90	590	86,864,274	75.7
Coal and crude oil	3	31	5,536,128	5.6	7	64	12,030,542	10.5
Coal and natural gas	1	6			1	6		
Crude oil	16	81	10,123,781	10.2	17	85	12,794,890	11.1
Crude oil, coal, and natural gas	2	9	2,624,465	2.7	2	8	3,100,278	2.7
Natural gas	1	6			1	7		
	115	740	98,842,049	100.0	118	760	114,789,984	100.0

CAPACITY.

The total annual manufacturing capacity of all the plants, either active or only temporarily closed at the end of 1922, according to manufacturers' reports, a few of which have been revised slightly for the sake of consistency, and a few estimates, was 146,203,000 barrels, an increase of nearly 1.3 per cent. According to these figures the total production of cement in 1922 was 78.5 per cent of the total capacity, whereas the production in 1921 represented 68.5 per cent of the apparent total capacity in that year. It is very difficult to arrive at a true approximation of the cement-manufacturing capacity of the country. Some manufacturers report varying totals from year to year, although the same equipment is indicated. For 1922 four concerns reported a capacity less than their actual production for the year, but due allowance was made for this oversight in the present estimates. One large company, operating many mills, which otherwise cooperates heartily, has for several years declined to furnish any capacity figures, and necessarily these have had to be estimated. The record production for one month during 1922 was reached in October, when 12,287,000 barrels was made. At this rate 147,444,000 barrels would be produced in a year, but in all probability the mills of the country could not sustain their maximum productivity for so long a period, even under the most favorable operating conditions and liveliest demand for cement. The capacity arrived at for 1920 was 146,400,000 barrels, which is slightly greater than that for 1922, and the figures originally published in the advance chapter for 1921 were 141,984,000 barrels. If the capacity for 1921 is estimated on a basis similar to that for 1922, a few reports being revised in order to make the data fairly consistent, a total of 144,354,000 barrels is obtained, an apparent increase of about 2,370,000 barrels over the original figures.

A recent article [6] offers some pertinent advice to show how dealers and users can help to avoid a shortage of cement at the time of peak

[6] Order it early if you want cement: Am. Contractor, Chicago, Ill., Mar. 24, 1923.

demand, as well as to help relieve the congestion in freight shipments, and enable the Portland cement mills to maintain a more steady rate of production, through the simple expedient of ordering early the cement that they will need later and storing it for use when transportation difficulties make prompt deliveries impossible. It is pointed out that manufacturing capacity can not be made adjustable to the spasmodic demands of the building industry, and that, although the mills of the country may be able, for example, to produce 12,000,000 barrels in one month, it is not possible for them to produce 24,000,000 barrels in one month to make up for shutdowns in some other month. Manufacturers can not afford to make and store a large quantity of cement for which they have no immediate demand, although many of them have done so in the early part of the year, a practice that entails the tying up of a large amount of capital and naturally has its effect on the price of cement. Beyond the accumulation of a safe reserve, the storage of finished cement by the manufacturers in winter for shipment later in the year tends to complicate the transportation situation, because the heaviest movement of crops, building material, and coal comes in the summer and fall, when the demand for railroad facilities exceeds the supply, so that car shortages are bound to occur, even though the railroad equipment is in good order. Dealers and contractors therefore find it advantageous to order and store cement early in the year, but in order to do this intelligently they must have some idea what their requirements will be, for Portland cement can not be stored indefinitely, and to this end they must have the cooperation of the architect, engineer, and banker. If all these forces are set in motion early in the year, much may be accomplished toward distributing the demand over a longer period of the year. A good step in this direction has been taken by several State highway departments, notably those of Indiana and Illinois, by inserting in their contracts the provision that a certain percentage of the cement required to complete each job must be kept in stock by the contractor. This provision should help materially to keep road work going in times of car shortage, but road work is handicapped because in most States it can not be carried on during the winter like some other kinds of construction work.

Portland cement manufacturing capacity of the United States, by commercial districts, 1921 and 1922.

District.	Estimated capacity (barrels).		Percentage of capacity utilized.	
	1921	1922	1921	1922
Eastern Pennsylvania, New Jersey, and Maryland	41,751,000	41,921,000	61.2	74.4
New York	8,450,000	8,567,000	62.7	69.1
Ohio, western Pennsylvania, and West Virginia	12,110,000	12,133,000	78.5	88.6
Michigan	8,006,000	7,930,000	72.2	78.7
Illinois, Indiana, and Kentucky	21,372,000	21,550,000	79.8	83.5
Virginia, Tennessee, Alabama, and Georgia	7,000,000	7,113,000	72.4	83.7
Eastern Missouri, Iowa, and Minnesota	13,975,000	14,177,000	71.2	80.4
Western Missouri, Nebraska, Kansas, and Oklahoma	9,790,000	10,215,000	64.9	78.6
Texas	4,050,000	4,425,000	65.9	82.0
Colorado and Utah	2,850,000	2,850,000	65.3	70.9
California	10,317,000	10,464,000	70.8	83.3
Oregon, Washington, and Montana	4,683,000	4,858,000	52.2	60.6
	144,354,000	146,203,000	68.5	78.5

RECOVERY OF POTASH.[7]

In 1922 the production of potash (K_2O) as a by-product of the manufacture of Portland cement was reported by only one manufacturing plant, as compared with three producers in 1921, and in accordance with the custom of the Geological Survey not to reveal statistics of individual producers without special permission, it will not be possible to publish any figures for 1922. The very great reduction in price of potash appears to be largely responsible for the discontinuance of this phase of the cement industry, although operating difficulties may have had some influence.

MASONRY, NATURAL, AND PUZZOLAN CEMENTS.

The term "masonry cement" has been introduced here for certain cements, made by grinding calcined calcareous rock, like natural cements, that are being used very largely in mortar for laying brick and stone, although of course other hydraulic cements are also suitable for masonry work.

Natural cement, including masonry cement, was produced in 1922 in eight plants, distributed in seven States—near Rosendale, N. Y.; Siegfried, Pa.; Lisbon, Ohio; Speeds, Ind.; Utica, Ill.; Fort Scott, Kans.; and Austin and Mankato, Minn.

One manufacturer with a plant at Birmingham, Ala., reports an output of puzzolan or slag-lime cement, and in order that this quantity may be included in the cement totals for the United States without revealing confidential information it is included with the statistics of masonry and natural cements.

The next table, which gives such statistics as may be presented concerning the output of masonry, natural, and puzzolan cements in 1921 and 1922, indicates an increase in quantity of about 65 per cent and in value of about 44 per cent as compared with the output in 1921. The average factory price per barrel in 1922 was $1.45, compared with $1.66 in 1921. The output has been expressed in terms of 376-pound barrels, to correspond with the statistics for Portland cement.

The second table presents quoted wholesale prices of these cements in lots of 500 barrels or more, exclusive of bags, f. o. b. at six widely separated cities in the United States, as published by the Engineering News-Record, 1922, but in order to make a consistent comparison of these prices it must be taken into consideration that weights per barrel of 240, 265, and 320 pounds are involved instead of the standard weight of Portland cement, which is 376 pounds. These cements are packed four sacks to the barrel, each sack holding about 1 cubic foot, as with Portland cement, but the lighter specific gravity of the non-Portland cements accounts for their smaller weight per barrel.

[7] For complete statistics of the production of potash salts see the chapter on potash in Mineral Resources for 1922.

Masonry, natural, and puzzolan cement shipped, 1921 and 1922.

State.	1921			1922		
	Producing plants.	Barrels.	Value.	Producing plants.	Barrels.	Value.
Alabama [a]	1	304,218	$528,587	1	497,081	$798,434
Illinois	1			1		
Indiana	1			1		
Kansas	1			1		
Minnesota	2	235,184	368,438	2	392,347	495,164
New York	1			1		
Ohio	1			1		
Pennsylvania	1			1		
	9	539,402	897,025	9	889,428	1,293,598

[a] Puzzolan only.

Wholesale prices [a] of masonry, natural, and puzzolan cements, 1921 and 1922, by months.

[Per barrel [b] except as otherwise noted.]

City and brand.	January.		February.		March.	
	1921	1922	1921	1922	1921	1922
Atlanta (Magnolia)	$1.90	[c] $11.00	[c] $11.00	[c] $11.00	[c] $11.00	[c] $11.00
Boston (Rosendale)	2.35	[d] .85 [d] .95	2.35	[d] .85 [d] .95	2.35	[d] .85
Cincinnati (Utica)	2.75	1.93	2.75	1.93	2.75	1.93
Kansas City (Fort Scott)	1.60	1.60	1.60	1.60	1.60	1.60
Minneapolis (Rosendale)	1.85	2.80	2.80	2.80	2.80	2.80
St. Louis (Carney hydrated)						

City and brand.	April.		May.		June.	
	1921	1922	1921	1922	1921	1922
Atlanta (Magnolia)	[c] $11.00	[c] $11.00	[c] $11.00	[c] $11.00	[c] $11.00	[c] $11.00
Boston (Rosendale)	2.35	[d] .80	3.00	[d] .80	3.00	[d] .80
Cincinnati (Utica)	2.75	1.77	2.75	1.77	2.75	1.77
Kansas City (Fort Scott)	1.60	1.60	1.60	1.60	1.60	1.60
Minneapolis (Rosendale)	2.80	2.80	2.80	2.80	2.80	2.80
St. Louis (Carney hydrated)				2.10		2.10

City and brand.	July.		August.		September.	
	1921	1922	1921	1922	1921	1922
Atlanta (Magnolia)	[c] $11.00	[c] $11.00	[c] $11.00	[c] $11.00	[c] $11.00	[c] $11.00
Boston (Rosendale)	2.85	[d] .80	[d] .95 [d] 1.05	[d] .80	[d] .95 [d] 1.05	
Cincinnati (Utica)	1.87	1.77	1.87	1.77	1.87	1.77
Kansas City (Fort Scott)	1.60	1.60	1.60	1.60	1.60	1.60
Minneapolis (Rosendale)	2.80	2.80	2.80	2.80	2.80	2.80
St. Louis (Carney)						1.87
St. Louis (Carney hydrated)		2.10		2.10		

[a] Price to dealers per barrel for 500 barrels or more, f. o. b., exclusive of bags; unless otherwise designated.
[b] Available information indicates that the weights per barrel of these cements are as follows: Rosendale, 320 pounds; Utica, 265 pounds; Fort Scott, 240 pounds; Carney, 240 pounds; Magnolia (puzzolan cement), 320 pounds.
[c] Per ton.
[d] Per bag.

Wholesale prices of masonry, natural, and puzzolan cements, 1921–1922, by months—Continued.

City and brand.	October.		November.		December.	
	1921	1922	1921	1922	1921	1922
Atlanta (Magnolia)	c $11.00	c $11.00	c $11.00	c $11.00	c $11.00	c $11.00
Boston (Rosendale)	d .95 d 1.05		d .85 d .95		d .85 d .95	
Cincinnati (Utica)	1.77	1.72	1.77	1.72	1.77	1.72
Kansas City (Fort Scott)	1.60	1.75	1.60	1.75	1.60	1.50
Minneapolis (Rosendale)	2.80	2.80	2.80	2.80	2.80	2.80
St. Louis (Carney)	.....	1.87	.....	1.75	.....	1.75
St. Louis (Carney hydrated)	.....	.....	.....	.....	.....	.....

c Per ton. d Per bag.

FOREIGN TRADE IN CEMENT.[8]

In 1922 the hydraulic cement exported to foreign countries, including the Philippine Islands and the Canal Zone, most of it Portland cement, decreased 4.5 per cent in quantity and 25 per cent in value. The quantity exported in 1922 was slightly less than 1 per cent of the total shipments of hydraulic cement in that year.

The exports were sent approximately as follows: To the West Indies, 528,000 barrels; South America, 330,000 barrels; Mexico, 103,000 barrels; Central America, 113,000 barrels; Canada, 29,000 barrels; and other countries, 25,000 barrels. The export trade varies from year to year but has never reached large proportions. In recent years strong competition from European manufacturers has undoubtedly restricted the market for American cement in foreign countries.

Hydraulic cement exported from the United States in 1921 and 1922, by countries.

Destination.	1921		1922			
			Portland.[a]		Natural.[a]	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
Argentina	22,870	$114,472	23,650	$122,840	1,401	$8,880
Azores and Madeira Islands	169	592	.....	.....	.....	.....
Belgian Congo	484	1,832	.....	.....	.....	.....
Belgium	214	1,419	128	855	.....	.....
Bermuda	1,811	6,078	2,492	7,627	.....	.....
Bolivia	24,646	92,892	4,830	12,586	.....	.....
Brazil	38,095	134,780	42,139	130,238	1,269	8,196
British East Indies:						
British India	701	3,714	25	185	.....	.....
Straits Settlements	701	4,472	390	2,470	.....	.....
British Guiana	990	4,227	.....	.....	.....	.....
British Honduras	445	1,824	4,321	11,268	.....	.....
British Oceania:						
Australia	570	3,593	138	902	242	1,798
British Oceania	.....	.....	335	1,106	.....	.....
New Zealand	253	1,377	529	3,566	510	3,417
Other	275	1,403	.....	.....	.....	.....
British South Africa	261	1,645	265	1,788	.....	.....
British West Indies:						
Barbados	8	27	5	19	.....	.....
Jamaica	7,076	26,140	4,388	11,981	1	10
Trinidad and Tobago	2,803	9,593	3,618	9,666	.....	.....
Other	10,287	34,432	25,511	64,886	455	2,241
Canada	5,984	26,968	28,416	81,807	843	5,564

[a] Not separately classified prior to 1922.

[8] Statistics of exports and imports were compiled by J. A. Dorsey from records of the Bureau of Foreign and Domestic Commerce.

Hydraulic cement exported from the United States in 1921 and 1922, by countries—Con.

Destination.	1921		1922			
			Portland.		Natural.	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
Canary Islands	1,330	$4,955	1,840	$5,726		
Ceylon			10	76		
Chile	10,274	38,686	14,350	41,290	262	$1,793
China	982	4,426	1,140	7,506		
Colombia	79,581	276,034	104,709	295,270	456	1,597
Costa Rica	4,224	15,796	4,654	13,953	55	408
Cuba	447,706	1,599,362	453,250	1,151,059	2,791	17,684
Dominican Republic	55,596	199,511	28,880	76,949	51	339
Dutch East Indies	5,465	31,790				
Dutch Guiana	990	3,680				
Dutch West Indies	10,383	38,888	1,488	4,675		
Ecuador	6,383	21,504	4,984	16,503		
Egypt			6	51		
England	1,377	7,470	4,187	26,236	1,488	7,884
France			57	157		
French Guiana	2,205	7,947	1,475	3,967	330	875
French Oceania	988	4,056	1,405	5,016		
French West Indies	1,635	6,014	2,805	8,339		
Germany	2	11				
Greece	50	375	50	375		
Guatemala	8,917	35,302	4,620	16,134	7	24
Haiti	13,983	43,713	4,445	10,679		
Honduras	19,797	70,267	27,700	79,806	171	734
Hongkong	79	428	73	539		
Iceland and Faroe Islands					16	86
Ireland			75	554	80	570
Japan	915	6,142	82	298		
Java and Madura			1,455	9,317	100	668
Liberia	50	200	17	98		
Mexico	192,817	690,556	100,378	317,111	2,299	12,864
Miquelon, Langley, and St. Pierre islands	164	499	660	1,282		
Netherlands	23	116	3	15		
Newfoundland and Labrador	1,000	3,500	449	1,389	10	74
Nicaragua	5,332	21,708	5,836	19,227		
Norway	132	872	60	469	30	210
Oceania (not otherwise specified)	600	2,850				
Palestine and Syria			125	800		
Panama	61,626	207,924	55,833	141,124		
Peru	76,504	255,735	93,250	231,813	225	1,437
Philippine Islands	3,389	11,591	5,063	14,406	320	2,652
Portugal	2,000	8,000				
Portuguese East Africa	214	666	29	87		
Portuguese Africa, other			86	425		
Russia in Asia			1	14		
Salvador	16,410	65,985	9,418	31,816	25	160
Scotland	100	690	4	28		
Siam			200	1,352		
Spain	127	967	321	2,080	875	2,665
Uruguay	4,320	28,335	4,681	30,060	200	1,291
Venezuela	23,944	85,948	31,392	87,421	295	1,747
Virgin Islands of the United States	807	3,007	310	975	2	13
	1,181,014	4,276,986	1,113,036	3,120,287	14,809	85,914

Domestic hydraulic cement shipped to Alaska, Hawaii, and Porto Rico in 1921 and 1922.

	1921		1922	
	Barrels.	Value.	Barrels.	Value.
Alaska	10,015	$41,239	20,345	$74,950
Hawaii	170,579	574,946	201,353	609,330
Porto Rico	116,082	395,046	125,418	323,338
	296,676	1,011,231	347,116	1,007,618

Hydraulic cement exported from the United States, 1917–1922.

Year.	Barrels.	Value.	Percentage of total shipments.	Year.	Barrels.	Value.	Percentage of total shipments.
1917	2,586,215	$5,328,536	2.8	1920	2,985,807	$10,045,369	3.1
1918	2,252,446	5,912,166	3.2	1921	1,181,014	4,276,986	1.2
1919	2,463,573	7,513,389	2.9	1922	1,127,845	3,206,201	1.0

The quantities given in the following table of imports include all kinds of hydraulic cement. Some of the cement imported evidently was not manufactured in the country from which it came to the United States.

The large increase in imports in 1920, which came mostly from Portland cement mills in Canada, was not maintained in 1921 and 1922, but the imports in these years were much larger than in any other year since 1914. The total imports are insignificant, however, being less than 0.3 per cent of the consumption in 1922. The average value assigned to the cement was $1.94 a barrel, compared with $3.18 in 1921. These values, it should be noted, are higher than the average factory prices of domestic Portland cement, and the value for 1922 is not greatly lower than market prices at docks in New York.

The tariff act of 1922 placed hydraulic cements on the free list, with the proviso that if any country imposes a duty on such cement coming from the United States, an equal duty shall be imposed upon such cement coming into the United States from such country.

Roman, Portland, and other hydraulic cements imported into the United States in 1922, by countries.

[General imports.]

Country.	Barrels.	Value.
Belgium	10,682	$20,555
Canada:		
Maritime Provinces	33,505	70,313
Quebec and Ontario	86,657	193,830
Prairie Provinces	185	350
British Columbia and Yukon	6,869	22,860
Denmark	118,499	199,484
Dominican Republic	53	170
England	12	38
France	1,668	3,324
Germany	6	10
Japan	3,890	12,100
Mexico	1,001	2,768
Netherlands	149	375
Norway	125	233
Poland and Danzig	6	13
Sweden	60,492	102,330
Turkey in Europe	24	93
	323,823	628,846

Foreign cement imported for consumption in the United States, 1915–1922.

Year.	Barrels.[a]	Year.	Barrels.[a]
1915	42,218	1919	8,931
1916	1,836	1920	524,604
1917	2,323	1921	122,317
1918	305	1922	355,931

[a] Barrels of 376 pounds in 1920–1922, and 380 pounds in earlier years.

CEMENT IN CANADA.

The following revised statistics of the production of cement in Canada were issued August 30, 1923, by the Dominion Bureau of Statistics, Canada:

The sales of cement in Canada in 1922 of 6,943,972 barrels exceeded the previous year's sales by 1,191,087 barrels. The total mill output amounted to 6,447,696 barrels, a decrease of 1,960 barrels from the 1921 total. No puzzolan cement was produced during the year.

Ten plants, having in all a daily capacity of 35,338 barrels, were operated during the year. In addition to these, there were at least 12 other plants in Canada which were idle during the whole period.

Ontario and Quebec were the principal producing Provinces, sales from the former amounting to 3,104,386 barrels, averaging $2.06 per barrel, and from the latter 2,660,935 barrels, at an average price of $2.22. The selling price in the other Provinces was as follows: Manitoba, $2.62; Alberta, $2.33; and British Columbia, $3, with a Dominion average of $2.22 per barrel.

Output, sales, and stocks of cement in Canada, 1922.

	Barrels.	Value.
Output	6,447,696	$14,324,715
Sold or used	6,943,972	15,438,481
Stocks Dec. 31, 1921	1,603,215	.....
Stocks Dec. 31, 1922	1,106,939	.....

FELDSPAR.

By Frank J. Katz.[1]

INTRODUCTION.

The feldspar deposits in the eastern United States have been described in bulletins by Bastin and Watts,[2] who also discuss the physical and chemical properties of feldspar, its uses, and the commercial availability of the deposits and methods of mining them. A recent report [3] discusses conditions in the feldspar industry with particular reference to inefficient methods and equipment of mines and mills, and gives some suggestions for improvement, especially as to the design of mills and the standardizing of grades and specifications for feldspar.

Preceding volumes of Mineral Resources contain information on changes and development in the feldspar industry in various States and on the composition, occurrence, and uses of feldspar, geology and mineralogy of feldspar deposits, and methods of mining and milling, supplementing that given in the publications above cited.

Statistics of production of feldspar in this report are presented separately in tabular form for the mine and quarry output (crude feldspar) and for the mill output (ground feldspar). The reports for years preceding 1921 have shown a combination of figures of value for crude and ground feldspar as sold by the producers which gives a distorted view of the relative importance of the States in production of feldspar and also of the value per unit of quantity. In order to avoid such distortion all the feldspar marketed is now reported as crude feldspar and credited to the States in which it was produced at the average value of such feldspar in each State, in spite of the fact that much of the feldspar was first marketed in the ground form.

PRODUCTION AND PRICES.

Crude feldspar.—The crude feldspar mined and sold or used in the United States in 1922 showed an increase of 27 per cent as compared with the production in 1921. The output for 1922 was smaller than that for 1920, which was the largest recorded, and also smaller

[1] The statistical canvass on which this report is based was conducted by Mrs. L. M. Beach, of the Geological Survey, who has also prepared the tables here presented.

[2] Bastin, E. S., Economic geology of the feldspar deposits of the United States: U. S. Geol. Survey Bull. 420, 1910. Watts, A. S., Mining and treatment of feldspar and kaolin in the southern Appalachian region: Bur. Mines Bull. 53, 1913; Feldspars of the New England and northern Appalachian States: Bur. Mines Bull. 92, 1916. These reports are no longer available for free distribution, but the first and third can be purchased from the Superintendent of Documents, Washington, D. C., for 20 cents and 25 cents, respectively, or the three reports may be consulted in most of the principal libraries of the United States.

[3] Bur. Mines Rept. Inv. 2311, January, 1922.

than in 1917, 1916, and 1914 but a little larger than the average for the decade 1912-1921. The trend of annual production is shown in the accompanying diagram.

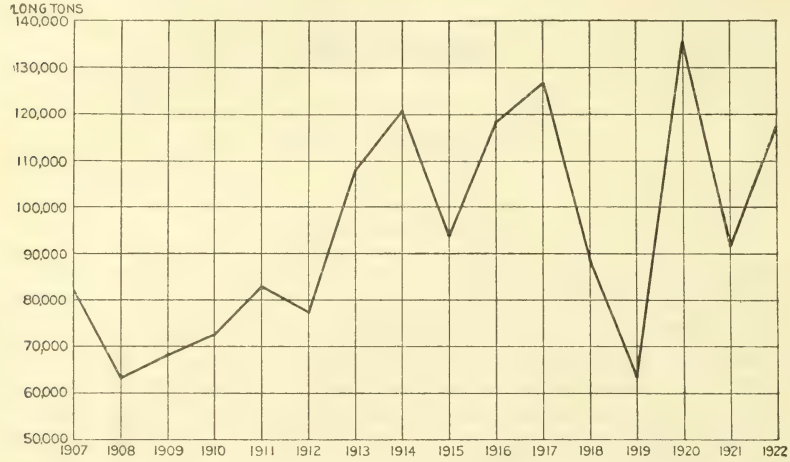

FIGURE 5.—Crude feldspar produced in the United States, 1907–1922.

The average value of all feldspar sold crude by the producers in 1922 was $6.78 a long ton f. o. b. at shipping points nearest the quarries. The average values as reported by individual producers ranged from $3 to $13.44 a long ton. For New England the range was from $5.95 to $13.44; for New York, Maryland, and Pennsylvania, from $3 to $8.36; for North Carolina from $3.86 to $7.48; and for California from $7 to $8.

Crude feldspar, produced in the United States, sold in 1917–1922.

Year.	Long tons.	Value.	Year.	Long tons.	Value.
1917	126,715	$474,767	1920	135,551	$851,123
1918	88,498	429,989	1921	91,865	617,652
1919	63,441	347,992	1922	117,127	844,568

Crude feldspar, produced in the United States, sold in 1921 and 1922.

State.	1921		1922	
	Long tons.	Value.[a]	Long tons.	Value.[a]
California	[b] 2,057	[b] $15,847	2,378	$17,510
Colorado	([b])	([b])	104	580
Connecticut	9,565	65,864	7,499	47,887
Maine	18,866	134,168	21,692	221,478
Maryland	5,155	33,798	2,899	18,099
New Hampshire	([c])	([c])	14,017	116,751
New York	([c])	([c])	([c])	([c])
North Carolina	40,712	259,603	56,043	333,745
Pennsylvania	([c])	([c])	([c])	([c])
Virginia			([c])	([c])
Undistributed	15,510	108,372	12,495	88,518
	91,865	617,652	117,127	844,568

[a] Value at mine or nearest shipping point.
[b] California includes a small quantity from Colorado.
[c] Included under "Undistributed."

Ground feldspar.—The available data relating to the production of ground feldspar have been unsatisfactory because they were incomplete. Probably all the feldspar consumed industrially is prepared by fine grinding except that used for facing cement work, for covering prepared roofing, and for "chicken grits" and like uses. Even for such purposes the spar is at least crushed to small sizes and more or less graded by screening, but it has not been possible to canvass all users of feldspar to determine the amounts ground and used by them. All known merchant mills or grinders—that is, those who quarry or purchase crude spar and grind it for sale to other establishments—have been canvassed for statistics of ground feldspar during the last two years.

From such information as has been obtained for the year 1921, it would appear that the total output of ground feldspar of both domestic and Canadian origin in the United States in 1921 was about 90,000 short tons, valued at $1,600,000 to $1,750,000. The average value per ton of ground feldspar sold in 1921, so far as reported to the United States Geological Survey by producers, was $17.91, and the averages as shown by the reports of individual producers ranged from $12.23 to $21.56. These averages cover various grades of ground feldspar at the mills in different States.

For 1922 the mills courteously furnished reports in considerable detail which are summarized here. A total of 127,044 short tons of feldspar, valued at $2,154,387, was ground and sold by 24 merchant mills in the United States. Nineteen mills worked on domestic spar exclusively, four on Canadian spar, and one on both. Of the total 85 per cent was domestic spar and 15 per cent Canadian spar. The average value f. o. b. mills of all domestic spar sold was $16.58 a ton and of all Canadian spar sold $19.09 a ton. Direct comparison of values is misleading, however, as the figure for Canadian spar relates to generally high-grade material at mills near points of consumption, whereas the figure for domestic spar covers all grades at various points, some distant from consuming centers. The average value of domestic spar ground at Trenton, N. J., Wilmington, Del., and East Liverpool, Ohio, approximately one-fifth of the total output, was $21.10 a ton.

Prices as reported by the producers at Trenton and East Liverpool ranged from $20 to $24 a short ton f. o. b. mills for various grades. In New England the corresponding range was $15 to $19.50, but special grades of "soap" spar were quoted as high as $25. At Tennessee and North Carolina mills various grades of ground spar were quoted at $9 to $17, with prices prevailing at about $15 for better grades of pottery spar.

Ground feldspar sold by merchant mills[a] in the United States in 1922.

State.	Operators.	Mills.	Domestic spar.		Canadian spar.	
			Short tons.	Value.	Short tons.	Value.
Maine, New Hampshire, and Connecticut	4	6	29,768	$539,433	.....	.....
New York, New Jersey, Pennsylvania, Delaware, Maryland, Ohio, and California	12	14	37,003	714,666	19,075	$364,082
Tennessee and North Carolina	4	4	41,198	536,206	.....	.....
	20	24	107,969	1,790,305	19,075	364,082

[a] Does not include potters and others who grind for consumption in their own plants.

THE INDUSTRY BY STATES.

Production of crude feldspar during 1922 was reported from the following States, named in the order of output: North Carolina, Maine, New Hampshire, New York, Connecticut, Maryland, California, Pennsylvania, Colorado, and Virginia. Feldspar was ground by merchant mills in each of these States except Colorado and Virginia and also in New Jersey, Delaware, Ohio, and Tennessee.

California.—Three operators in Los Angeles, Riverside, and San Diego counties, Calif., reported production of crude spar in 1922 amounting to 2,378 long tons, valued at $17,510, or $7.36 a ton. Part of this spar was sold crude to consumers within the State, and part was sold ground by the American Encaustic Tiling Co., Los Angeles.

Colorado.—Colorado has been an intermittent producer of feldspar in small lots. In 1922 production was reported by a single operator in Jefferson County.

Connecticut.—The output of feldspar in Connecticut in 1922 came chiefly from the Howe quarry, in South Glastonbury, Hartford County, and the Strickland quarry, in Portland, Middlesex County, which have been steadily producing for many years. A considerable quantity was also produced by the C. H. Cook Spar & Quartz Co. from a recently developed quarry near Newtown, in Fairfield County. Three other quarries contributed to the total of 7,499 long tons of crude spar. The product from the Howe quarry was ground at L. W. Howe's mill at South Glastonbury. The bulk of the output from other quarries was taken by mills in Trenton, N. J., and East Liverpool, Ohio, and a small remainder was used in making soap and glass.

Delaware.—No crude feldspar has been produced in Delaware. The Golding Sons Co.'s mill at Wilmington operated during the year on crude feldspar from Maine and Maryland.

Maine.—Maine ranked second among the States in output of crude feldspar in 1922, with a total of 21,692 long tons, valued at $221,478, or $10.21 a ton, and was also second in quantity of ground spar sold. Nine quarries in Sagadahoc, Androscoggin, and Oxford counties were reported active, including the long established plants of the Maine Feldspar Co. in Topsham and at Mount Apatite, the Willis quarries in Cathance and Bowdoinham, the Cummings quarry in Bowdoinham, and the Golding quarry in Georgetown. Grinding plants were operated by the Maine Feldspar Co. at Topsham and Auburn, the Trenton Flint & Spar Co. at Cathance, and the J. W. Cummings Feldspar Co. at Bath.

Maryland.—A total of 2,899 long tons of feldspar was reported by seven operators from five quarries in Maryland in 1922. This spar was sold for $18,099, or $6.24 a ton. The Product Operating Co. ground and sold feldspar at its mill in Claremont, Baltimore.

New Hampshire.—A total output of 14,017 long tons of crude feldspar, valued at $116,751, or $8.33 a ton, gave New Hampshire third rank among the feldspar-producing States in 1922. The principal producer was the Keene Mica Products Co., whose quarry, which had long been operated as a mica mine, is in Alstead, Cheshire County. The Federal Lumber Co. began to produce feldspar late in the year in Grafton County, and the Eastern Mining Co., in

Carroll County, was also reported productive. Early in 1922 the Golding-Keene Co. was formed and built a mill at Keene to grind the feldspar produced by the Keene Mica Products Co. These operations have been described by Ladoo.[4]

New Jersey.—New Jersey is not a feldspar-producing State, but at Trenton are located the mills of the Eureka Flint & Spar Co. and Golding Sons Co. The city is both one of the principal feldspar markets and by reason of its potteries one of the principal centers of feldspar consumption.

New York.—Feldspar was mined in New York in 1922 by the Bedford Mining Co. in Westchester County and the Green Hill Mining Co. in St. Lawrence County. The formerly important southern Adirondack region, in Fulton, Saratoga, and Hamilton counties, has ceased to be productive. The State has four mills for grinding feldspar—those of the Bedford Mining Co. at Bedford, Westchester County, grinding domestic spar; and the Dominion Feldspar Corporation at Rochester, the Pennsylvania Pulverizing Co. at Rochester, and the Genesee Feldspar Co. (Inc.) at Genesee Dock, grinding Canadian spar.

North Carolina.—North Carolina has for several years maintained the lead in feldspar production. Its total output in 1922 was 56,043 long tons, valued at $333,745, or $5.96 a ton. Except only the output by the Southern Spar & Mica Co. from Swannanoa, Buncombe County, all the feldspar produced in North Carolina came from the territory tributary to the Carolina, Clinchfield & Ohio Railway in Avery, Mitchell, and Yancey counties, sometimes called the Spruce Pine district. This is a region of abundant pegmatite dikes, which have been mined for mica and gems and, where decomposed, for kaolin. Feldspar mining first became established here in 1911, largely through the activities of the late William E. Dibbell, who founded the Carolina Mineral Co. and shipped about 1,000 tons that year from quarries near Penland. North Carolina ranked sixth among the States in 1912 and fifth in 1913 and 1914, then jumped to second place in 1915 and to first place in 1916, which it has since yielded to Maine only in 1920. North Carolina owes its present supremacy as a feldspar producer to the combination of numerous easily worked pegmatite bodies, location near a railroad giving advantageous connection with a market, and cheap labor. During recent years there have doubtless been more than a hundred quarries, small and large, operated for feldspar each year in the Spruce Pine district. More than half of these have been worked only fitfully and in a small way by farmer owners whose individual yearly sales ranged from a single wagon load to about 100 tons. Such producers sell or barter feldspar at Spruce Pine, Penland, or other stations on the railroad, whence it is taken by the milling companies or finally reaches the market through the larger and more firmly established producers. It is only through the courtesy of these companies in furnishing detailed statements of purchases that the Geological Survey is able to report the output of the region fully and without endless duplication. Among the well-established operators who were active in 1922 were the Big Ridge Mining Co. near Spruce Pine, Edward Blake at

[4] Ladoo, R. B., Feldspar mining and milling near Keene, N. H.: Cement, Mill, and Quarry, Nov. 5, 1922, pp. 35–38.

Newdale, the Carolina Feldspar Co. near Micaville, the Carolina Mineral Co. near Spruce Pine and Estatoe, the Clinchfield Products Co. at Hawkins and Bowditch, the Crabtree Feldspar Corporation at Crabtree Falls, the Penland Feldspar & Kaolin Co. at Penland, J. C. Pitman near Penland, Lewis Robinson near Burnsville, Willms & Son near Spruce Pine, the Wiseman Mines Corporation near Spruce Pine, G. C. Harris near Windom, H. C. Smith near Burnsville, the Mineral Products Co. near Penland, and the Erwin Feldspar Corporation near Spruce Pine.

Hitherto practically all North Carolina spar has been shipped crude, much of it going to mills at Erwin, Tenn. In 1921, however, a grinding plant was built by the Carolina Mineral Co. on Caney Fork near Micaville, in Yancey County, and this mill shipped ground feldspar during 1922. Another mill near Micaville is now (1923) reported under construction by the North State Feldspar Co.

Ohio.—The pottery, tile, and enamel works in Ohio use more feldspar than is used in any other State. These works are supplied partly by mills within the State operated by Golding Sons Co. and the Potters Mining & Milling Co. at East Liverpool, which grind domestic spar; and the Cleveland Feldspar & Products Co. at Cleveland and the Rock Products Co. at Silica, near Toledo, which grind Canadian spar.

Pennsylvania.—Only two feldspar quarries in Pennsylvania reported production in 1922, and their output was small. The American Feldspar Co. operated a mill at Toughkenamon.

Tennessee.—The feldspar industry in Tennessee is represented only by grinding mills. Three of these, operated by the Clinchfield Products Co., the Erwin Feldspar Co., and Carl Willms, jr., are at Erwin, on the Carolina, Clinchfield & Ohio Railway, and draw their crude spar from the Spruce Pine district of North Carolina. A fourth mill was under construction by the Mineral Products Co. at Bristol during the year.

Virginia.—A few tons of spar was sold in 1922 by the Vicama Mica Co. from its mica mine in Henry County, Va.

QUALITY OF FELDSPAR.

Essentially all the feldspars produced commercially in the United States and Canada are perthitic intergrowths of microcline and albite, in which microcline predominates. They are chemically, therefore, alkali feldspars which contain more potash than soda. Most of the commercial feldspars are high-potash feldspars. The feldspar formerly mined in the Sylmar district, in Maryland and Pennsylvania, and some of the feldspar produced in Westchester County, N. Y., is albite or soda feldspar. At present practically no soda feldspar is being produced as such. However, an important if not a major part of the feldspar deposits at present worked in the United States contain some albite or soda feldspar, distinct from the perthitic potash spar for which the deposits are worked. In such deposits the potash feldspar occurs for the most part as large crystals, whereas the soda feldspar is usually in aggregates of smaller crystals commingled with quartz, mica, and other mineral constituents of pegmatites. These commingled aggregates of feldspar, quartz, mica, and other minerals are cobbed out or otherwise

sorted from the merchantable feldspar, but the sorting is almost never complete, and therefore the output from many of the feldspar deposits contains a variable amount of soda spar, which affects the chemical composition and physical properties of the product as a whole. Because of the incomplete separation of feldspar from its associated minerals the composition of the marketed product never matches and rarely approximates analyses of clean feldspar.

The most abundant constituent of commercial feldspar, other than feldspar itself, is quartz. Except for dental feldspar and some soap feldspar, quartz is not a detrimental impurity. It may be considered rather as a diluent, chiefly because in the manufacture of most ceramic wares quartz or some other form of silica is an essential ingredient. Muscovite or white mica in small quantities is also not a detrimental impurity, but in anything more than relatively small quantities it should be so considered. Other mineral constituents of the pegmatites, particularly the dark-colored minerals, such as black mica, biotite, tourmaline, and garnet, are harmful impurities because of their effect in coloring or mottling and speckling the ceramic wares manufactured from feldspar.

All feldspar deposits are affected by weathering, at least at the surface of the deposits, and in the Southern States the weathering may extend to great depths. The effects are principally of two kinds—an alteration of the feldspar itself, which when carried to completion changes feldspar to sericite or kaolin or both, and the staining and impregnating of the feldspar with iron oxide, clay, earthy materials, and other deleterious impurities as the result of infiltration of surface water.

The quality of commercial feldspar will depend upon the care exercised in quarrying and sorting the quarried product to secure feldspar of uniform composition by avoiding mixtures of two or more varieties of feldspar that may occur in the deposit or by preparing uniform mixtures of such varieties. Further, the quality of the feldspar will depend upon care in eliminating excess quartz and harmful mineral ingredients, weathered feldspar, and adhering infiltrated products of weathering of other minerals. The inherent differences between feldspar deposits and the varying conditions of weathering, together with a lack of uniformity in treatment of feldspar during quarrying by different operators, all contribute to wide differences in the quality of feldspar produced at different times and in different places.

During the last few years the attention of feldspar producers, consumers, and other students of the industry has been focused on the matter of grading feldspar. It would appear that although several systems of grading are in use, no generally accepted standard grades or specifications have been established. Because of the diverse character of feldspar deposits it is very doubtful if standard specifications or grades can be established for general use by all producers and consumers. It is probable, however, that each of the larger, more firmly established producers will be obliged to attempt standardization of his own product by holding it within definite limits of tolerance as to chemical composition, content of impurities and diluents, and fineness and uniformity of grinding of the product, if sold ground. The importance of standardizing and of specifications

has been emphasized in two recent papers, one by Raymond B. Ladoo, mineral technologist, Bureau of Mines,[5] and the other by Arthur S. Watts, professor of ceramic engineering, Ohio State University.[6]

A few of the producing companies are maintaining approximate uniformity in their output, largely by careful selection of material quarried and control of grinding operations. The nature of the feldspar deposits, however, is such that thorough selection of the material handled in the quarries necessarily slows up quarry operations and reduces output, so that the operator has difficulty in meeting the pressure from consumers for reduction in price of the raw material. Satisfactory agreement between producers and consumers of feldspar will probably not be reached until the consumer thoroughly recognizes the producers' difficulties and makes due allowance for them. On the other hand, there are still numerous producers who need to recognize the consumers' requirements with reference to comparative purity and uniformity. Such practice as is now common in North Carolina of assembling crude spar mined by a number of small producers, whose only interest is in the barter value of a few wagon loads, is calculated to discredit the quality of North Carolina feldspar. A similar effect is produced by the practice of some of the larger operators themselves of alternately or successively mining comparatively small lots from various deposits. It is suggested that the larger operators would do well to abandon this practice and to search for and concentrate their efforts on the operation of large bodies of pegmatite, which are more likely to yield a uniform product over a number of years.

FOREIGN TRADE.

The foreign trade of the United States in feldspar is small and limited largely to importing from Canada. There is no record of exports of feldspar, and if any they are doubtless negligible in quantity. Prior to September 22, 1922, imports of feldspar were not specifically classified in the official records and are therefore unknown. From that date to the end of the year the imports amounted to 7,549 long tons of crude feldspar, valued at $60,111, and 37 long tons of crushed or ground feldspar, valued at $538.

FOREIGN PRODUCTION.

The supply of feldspar annually available for the ceramic and other feldspar-consuming industries in the United States is made up in considerable part of feldspar mined in Canada. According to reports of the Dominion Bureau of Statistics the shipments in Canada in 1922 amounted to 27,878 short tons, valued at $227,625, all from Ontario and Quebec. Of this quantity 24,975 tons, nearly all in crude form, was exported to the United States. As shown in the following table the Canadian shipments in 1922, although considerably less than in 1920 and 1921, were much larger than in any year prior to 1920. This increasing production of Canadian feld-

[5] Conditions in the feldspar industry, January, 1922: Bur. Mines Rept. Inv. 2311.

[6] The marketing of feldspar; many varieties produced in United States; no standard grades and specifications recognized by the trade: Eng. and Min. Jour.-Press, vol. 115, pp. 535–538, Mar. 24, 1923.

spar is cutting in on the market for domestic spar. As shown in a preceding table the sales of Canadian spar ground in the United States amounted to 15 per cent of the total sales in this country in 1922.

Feldspar sold in Canada, 1917–1922.[a]

Year.	Short tons.	Value.	Year.	Short tons.	Value.
1917	19,462	$89,826	1920	37,873	$280,895
1918	18,782	112,728	1921	29,868	230,754
1919	14,679	86,231	1922[b]	27,878	227,625

[a] Statistics taken from reports on the mineral production of Canada, Canada Dept. Mines, prior to 1921; for 1921 and 1922 from Dominion Bureau of Statistics.
[b] Figures for 1922 preliminary and subject to revision.

The most recent figures for the production of feldspar in other foreign countries are shown in the accompanying table. Norway and Sweden are important producers, and Germany also produces a considerable quantity. Feldspar is also quarried in France.

Feldspar output of principal producing countries, 1917–1922, in metric tons.[a]

Country.	1917	1918	1919	1920	1921	1922
Canada	17,656	17,039	13,316	34,358	27,096	25,290
Germany (Bavaria)	2,530	3,772	6,527	5,850	(b)	(b)
Italy	1,292	1,517	1,100	2,600	2,460	(b)
Norway[c]	4,435	3,488	5,166	6,397	9,348	11,833
Sweden	18,533	17,850	12,905	12,049	(b)	(b)
United Kingdom	986	2,461	4,903	(b)	(b)	(b)
United States	128,749	89,918	64,459	137,727	93,339	119,007

[a] Sources of information: Canada, 1917–1920, Canada Dept. Mines; 1921–1922, Dominion Bureau of Statistics. Germany, Glückauf, Nov. 8, 1919; Aug. 7, 1920; Jan. 14, 1922; consular report, Mar. 18, 1922. Italy, Rivista del servizio minerario. Norway, Norges Bergverksdrift, Norges Offisielle Statistikk. Sweden, Sveriges Officiella Statistik Bergshantering. United Kingdom, Imperial Mineral Resources Bureau.
[b] Statistics not available.
[c] Includes crude and ground feldspar.

STONE.

By G. F. Loughlin and A. T. Coons.

PRODUCTION.

SUMMARY.

The sales of stone in the United States in 1922 reflected the recovery of the entire mineral industry of the country from the industrial depression of 1921. There was an increase of 26 per cent in quantity of stone sold and of 14 per cent in value. The quantity sold was the largest since 1917 and the value ranked next to the record value of 1920. The only kinds of stone showing decrease were the varieties included under "miscellaneous" and used chiefly for road metal, concrete, and ballast. Much of this material is obtained from local quarries, and the production is influenced by the local activity or inactivity in construction.

The tables of this report give values f. o. b. quarry or mill.

PRODUCTION BY KINDS AND USES.

Stone sold in the United States, 1920–1922, by kinds.

[Quantities approximate.]

Year.	Granite.		Basalt and related rocks (trap rock).		Sandstone.		Marble.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1920	4,760,000	$24,954,908	9,219,200	$12,260,148	3,343,000	$7,310,290	431,500	$11,069,585
1921	4,752,180	20,592,217	8,524,480	11,450,899	2,640,460	6,425,339	315,400	8,580,416
1922	5,913,120	21,125,869	10,032,900	12,600,611	3,388,130	7,521,044	427,870	10,534,671
Percentage of change in 1922	+24	+3	+18	+10	+28	+17	+36	+23

Year.	Limestone.		Miscellaneous.[a]		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
1920	59,290,000	$75,655,260	1,483,300	$2,291,769	78,527,000	$133,541,960
1921	45,621,000	57,749,594	1,685,220	2,163,801	63,538,740	106,962,266
1922	58,928,660	68,397,927	1,520,880	1,886,806	80,211,560	122,066,928
Percentage of change in 1922	+29	+18	−10	−13	+26	+14

[a] Includes mica schist, conglomerate, argillite, various light volcanic rocks, serpentine not used as marble, and such other stone as can not be properly classed in any of the main groups.

There was a good demand during the year for nearly all kinds of stone, but the production of monumental and building stone, paving blocks, curbstone, and flagstone was somewhat affected by labor

troubles, which caused a reduced output from certain quarries and cutting plants, especially at the principal granite centers in the New England States. Decrease in total output was shown, however, for only paving blocks and flagstone. Trouble was also experienced in getting transportation for crushed stone and other stone products. The cost of quarrying was somewhat less in 1922 than in 1921, and average prices were lower.

The relative importance to the stone industry of the different stone products, both in quantity sold and in value, and the fluctuation of the total output of stone are shown graphically in Figures 6, 7, and 8. Figures 6 and 7 exhibit strikingly the great predominance of crushed stone and the rapid increase in sales of it since 1918. The increase in sales even in the dull years of 1919 and 1921 is the result of compensation for curtailment in building and road construction during the war. The output of stone for flux, refractories, and manufacturing industries, on the other hand, corresponds closely with the trend of general industrial conditions, decreasing moderately in 1919 and markedly in 1921 and making a satisfactory recovery in 1922.

Another striking feature shown by Figure 6 is the relative insignificance of building and monumental stone when compared with crushed stone on the basis of quantity. There is much less contrast in Figure 7, where they are compared on the basis of value. The quantities of building and monumental stone sold are shown more clearly in Figure 8. There the curve for building stone has the same general trend as that for crushed stone in Figure 6 and is to be similarly explained. The curve for monumental stone reflects individual prosperity, which continued into 1919 in spite of general industrial depression but declined during 1920 and 1921. The recovery of this branch of the industry in 1922 was retarded by labor troubles.

Stone sold in the United States, 1921–22, by uses.

Use.	1921		1922	
	Quantity.	Value.	Quantity.	Value.
Building stone.....cubic feet..	17,006,210	$18,975,819	24,262,250	$25,749,398
Approximate equivalent in short tons.....	1,368,650		1,929,260	
Monumental stone.....cubic feet..	2,772,000	10,353,105	2,974,920	10,567,110
Approximate equivalent in short tons.....	230,000		248,270	
Paving blocks.....number..	41,588,860	3,593,373	31,208,800	2,685,234
Approximate equivalent in short tons.....	453,130		326,290	
Curbing.....cubic feet..	2,255,770	1,859,926	2,867,800	2,137,193
Approximate equivalent in short tons.....	183,600		236,030	
Flagging.....cubic feet..	791,660	471,837	650,590	406,731
Approximate equivalent in short tons.....	65,100		53,580	
Rubble.....short tons..	445,210	601,208	632,100	947,680
Riprap.....do....	1,813,590	1,694,206	2,048,580	1,768,939
Crushed stone.....do....	43,202,840	51,717,478	49,763,740	54,130,177
Furnace flux (limestone and marble).....long tons..	9,525,900	9,457,946	16,712,500	14,247,024
Equivalent in short tons.....	10,669,000		18,718,000	
Refractory stone (ganister, mica schist, and dolomite), ...short tons..	496,150	643,638	902,170	1,136,236
Manufacturing industries (limestone and marble), ...short tons..	2,883,090	3,801,162	3,586,250	3,414,073
Other uses [a].....do....	1,728,380	3,792,568	1,767,290	4,877,133
Total (quantities approximate, in short tons)...	63,538,740	106,962,266	80,211,560	122,066,928

[a] Chiefly agricultural limestone. (See pp. 310 and 312.)

All products shown in the preceding table increased in output in 1922 except paving blocks and flagstone, but only crushed stone and stone used for refractory purposes exceeded the output of 1916,

the year of the largest recorded stone production and the first year in which dolomite for refractories attained importance. Limestone and marble for fluxing material increased 75 per cent. Monumental

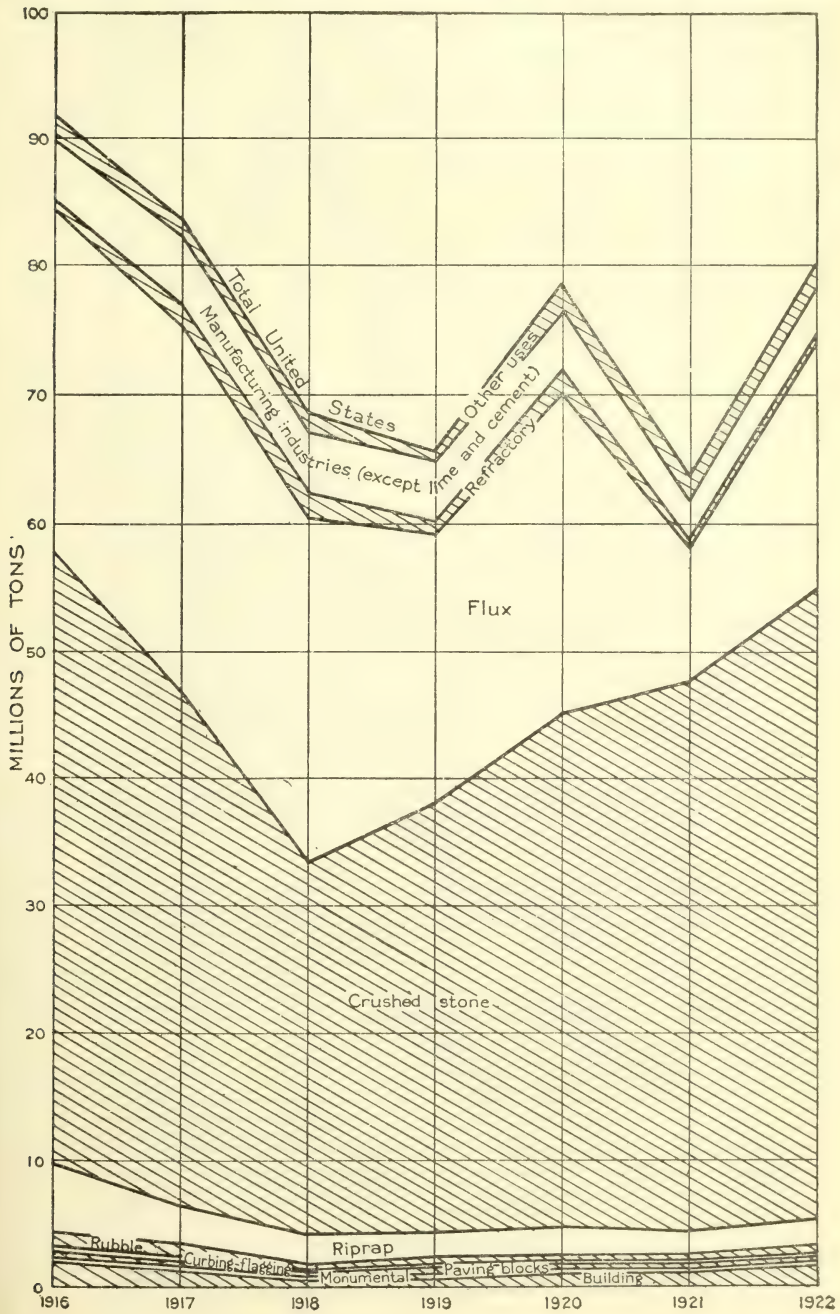

FIGURE 6.—Quantity of stone sold in the United States, 1916–1922, by uses.

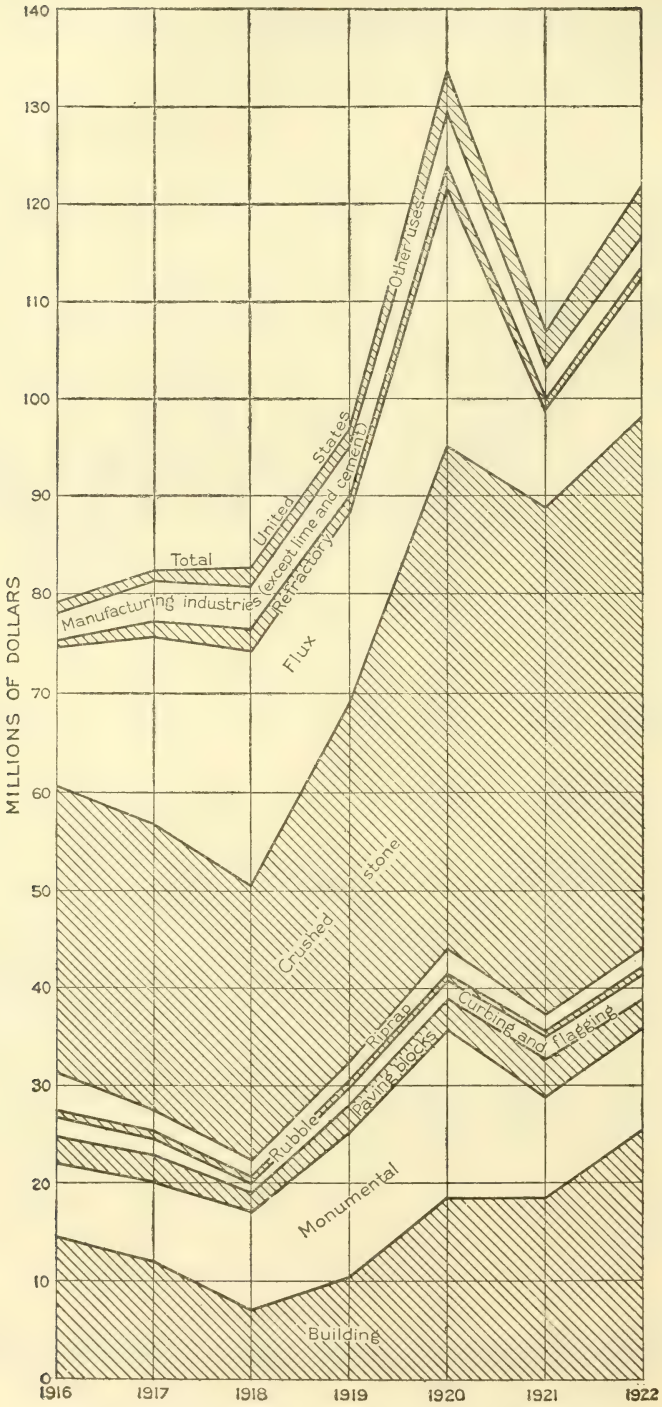

FIGURE 7.—Value of stone sold in the United States, 1916–1922, by uses.

stone increased 7 per cent notwithstanding a protracted strike in some of the monumental-granite districts during the year. Paving blocks were in good demand, but a strike among the paving-block cutters at several plants curtailed the output 25 per cent.

Building stone showed an increase of 43 per cent and was in good demand throughout the country. The Indiana oolitic limestone used for building increased 82 per cent in quantity, Carthage building stone increased 32 per cent, Ohio sandstone for building increased

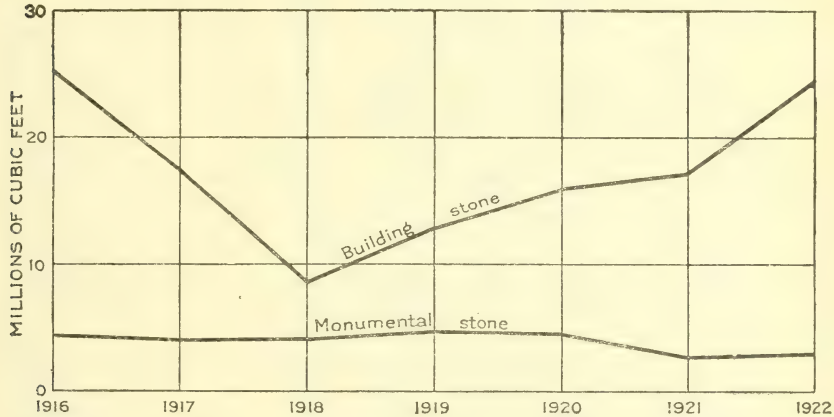

FIGURE 8.—Quantity of building and monumental stone sold in the United States, 1916–1922.

16 per cent, and in the less well defined districts there were increases in some but decreases in others. The total quantity of all kinds of building stone increased for 1922 as did the total for each kind.

The average total value per cubic foot of all building stone decreased somewhat in 1922, after a considerable decrease in 1921; but the cost of producing the more expensive grades kept the selling price high enough to restrict the market. Sawed stone showed the greatest increase in quantity, 73 per cent, and stone sold rough for high-class architectural work the next, 52 per cent. Cut stone increased 43 per cent, and rough stone for foundation work, sea walls, rough bridge work, etc., increased 24 per cent. No sharp line can be drawn between stone sold for rough construction work and that sold as rubble, which also increased in quantity. Much of the stone reported as rubble is used for building, as the recent trend has been to use small blocks of irregular shape, even in high-class dwellings and churches. Stone of this kind obtained in the excavation of cellars, especially in large cities like Philadelphia, has been used as the face stone of the dwellings. This development is interesting in view of recent reports on structural materials which show that the lumber supply of the Eastern, Southern, and Middle States has become so depleted that western timber is sold in the eastern markets at the high prices necessitated by the cost of transportation. Brick has also increased in price and has been hard to obtain. To supply the demand for structures in which these materials have ordinarily been used, rough stone for exterior work and sawed limestone or sandstone for both exterior and interior work may be furnished at little or no increase in cost.

Building stone sold in the United States in 1921 and 1922.

	Rough.				Dressed.				Total.	
	Constructional.		Architectural.		Sawed.[a]		Cut.[a]			
	Cubic feet.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Cubic feet.	Value.
1921.										
Granite	3,130,840	$559,104	443,860	$480,934	[a] 63,850	[a] $116,425	[a] 413,100	[a] $3,049,883	4,051,650	$4,206,346
Sandstone	1,387,000	166,049	572,360	329,690	777,760	879,330	79,120	236,970	2,816,240	1,612,039
Limestone	2,153,000	253,786	2,458,780	1,699,783	2,078,630	2,195,397	1,329,290	3,737,620	8,019,700	7,886,586
Marble	.....	.....	845,290	1,686,796	273,160	1,233,858	353,770	2,275,453	1,472,220	5,196,107
Basalt	346,400	24,679	.....	.....	.....	.....	.....	.....	346,400	24,679
Miscellaneous	300,000	50,062	.....	.....	.....	.....	.....	.....	300,000	50,062
	7,317,240	1,053,680	4,320,290	4,197,203	3,193,400	4,425,010	2,175,280	9,299,926	17,006,210	18,975,819
Average value	.....	0.14	.....	0.97	.....	1.39	.....	4.28	.....	1.12
1922.										
Granite	3,746,740	550,247	791,610	778,366	[a] 112,610	[a] 157,560	[a] 407,360	[a] 2,760,958	5,058,320	4,247,131
Sandstone	1,250,600	157,995	624,500	353,047	894,790	953,572	196,510	482,943	2,966,400	1,947,557
Limestone	2,421,800	271,343	4,352,030	2,577,416	3,880,950	3,713,028	1,962,600	5,857,086	12,617,380	12,418,873
Marble	.....	.....	807,420	1,880,861	620,980	1,626,752	535,360	3,414,770	1,963,760	6,922,383
Basalt	603,070	71,685	.....	.....	.....	.....	.....	.....	603,070	71,685
Miscellaneous	1,053,320	141,769	.....	.....	.....	.....	.....	.....	1,053,320	141,769
	9,075,530	1,193,039	6,575,560	5,589,690	5,509,330	6,450,912	3,101,830	12,515,757	24,262,250	25,749,398
Average value	.....	0.13	.....	0.85	.....	1.17	.....	4.03	.....	1.06

[a] For granite, sawed stone corresponds to dressed stone for construction work (walls, foundations, bridges) and cut stone to architectural stone for high-class buildings.

PRODUCTION BY STATES.

Stone sold in the United States in 1922, by States.[a]

State.	Number of active plants.	Quantity (approximate).		Value.	
		Short tons.	Percentage of total.	Dollars.	Percentage of total.
Pennsylvania	455	12,731,940	15.9	14,591,194	12
Indiana	91	2,775,740	3.5	13,203,146	10.8
Ohio	134	9,137,480	11.4	9,564,640	7.8
New York	155	[a] 6,463,770	8.0	[a] 8,744,124	7.2
California	112	5,521,690	6.9	6,879,002	5.6
Illinois	74	6,781,310	8.4	6,473,566	5.3
Vermont	48	190,410	.2	5,331,970	4.4
Michigan	32	[a] 7,741,110	9.7	[a] 4,910,786	4
Massachusetts	94	1,607,970	2	4,375,387	3.6
Tennessee	44	[a] 1,091,530	1.4	[a] 3,759,876	3.1
Georgia	35	444,590	.6	3,349,293	2.7
Missouri	99	1,611,020	2	3,322,672	2.7
Wisconsin	102	[a] 1,800,230	2.2	[a] 3,310,387	2.7
Minnesota	59	656,970	.8	3,163,716	2.6
New Jersey	59	1,903,840	2.4	2,850,557	2.3
North Carolina	29	[a] 948,810	1.2	[a] 2,483,851	2
West Virginia	33	2,163,470	2.7	2,134,944	1.7
Maine	49	191,760	.2	1,903,084	1.6
Kentucky	71	1,537,690	1.9	1,853,851	1.5
Virginia	57	1,626,740	2	1,801,778	1.5
Connecticut	37	[a] 1,420,710	1.8	[a] 1,585,461	1.3
Maryland	36	997,260	1.2	1,435,923	1.2
Oklahoma	28	1,156,950	1.4	1,327,370	1.1
Texas	29	1,335,660	1.7	1,314,203	1.1
South Carolina	12	638,400	.8	1,175,049	1
New Hampshire	27	128,650	.2	1,071,556	.9
Oregon	55	661,070	.8	897,784	.7
Kansas	50	657,660	.8	895,476	.7
Washington	31	[a] 647,160	.8	[a] 887,175	.7
Alabama	21	[a] 863,910	1.1	[a] 828,435	.7
Florida	10	[a] 770,140	1	[a] 706,644	.6
Iowa	38	620,810	.8	657,161	.5
Colorado	49	[a] 427,880	.5	[a] 555,694	.5
Hawaii	7	257,040	.3	500,892	.4
Arkansas	12	300,970	.4	417,729	.3
Utah	16	411,590	.5	380,246	.3
Rhode Island	15	[a] 73,400	.1	[a] 357,635	.3
South Dakota	15	133,920	.2	272,152	.2
Idaho	12	166,650	.2	235,241	.2
Nebraska	7	182,960	.2	231,195	.2
New Mexico	5	366,300	.5	224,525	.2
Montana	14	[a] 184,010	.2	[a] 211,293	.2
Wyoming	9	104,390	.1	205,798	.2
Porto Rico	11	90,480	.1	202,710	.2
Delaware	2	(b)	(b)	(b)	(b)
Alaska	1	(b)	(b)	(b)	(b)
Louisiana	2	(b)	(b)	(b)	(b)
Arizona	13	287,600	.4	120,206	.1
Nevada	2	(b)	(b)	(b)	(b)
District of Columbia	5	11,110	(b)	18,658	(b)
Mississippi	1	(b)	(b)	(b)	(b)
Undistributed	.....	386,810	.5	1,342,893	1.1
	2,404	80,211,360	100.0	122,066,928	100.0

[a] To avoid disclosing confidential information certain State totals are slightly incomplete, the figures not included being combined under "Undistributed."
[b] Included under "Undistributed."

EXPORTS AND IMPORTS.[1]

Stone exported from the United States, 1918–1922.

Kind.	1918	1919	1920	1921	1922
Marble and stone, unmanufactured	$552,261	$770,392	$774,442	$576,905	$681,658
All other, manufactured	1,208,164	1,508,997	2,158,764	1,697,570	903,102
	1,760,425	2,279,389	2,933,206	2,274,475	1,584,760

Stone imported for consumption in the United States in 1921–1922.

Kind.	1921		1922	
	Quantity.	Value.	Quantity.	Value.
Marble:				
In blocks, rough, etc.....cubic feet	388,731	$810,850	[a] 546,400	[a] $1,137,154
Sawed.....do	[b]	105	42	112
Slabs or paving tiles.....square feet	112,470	44,333	[a] 294,549	[a] 84,471
All other manufactures		103,273		[a] 196,754
Mosaic cubes of marble or onyx:				
Loose		30,865		25,259
Attached to paper		581		665
		990,007		[a] 1,444,415
Onyx:				
In blocks, rough, etc.....cubic feet	1,010	4,115	[a] 2,134	[a] 12,357
Slabs or paving tiles.....square feet	10,470	3,832	[a] 2,019	[a] 616
All other manufactures		9,990		[a] 4,906
		17,937		[a] 17,879
Granite:				
Dressed		108,219		183,776
Rough.....cubic feet	32,525	27,258	72,061	106,121
		135,477		289,897
Stone (other):				
Dressed		30,419		18,124
Rough (monumental or building stone).cubic feet	53,116	54,181	63,944	68,416
Rough (other)		25,938		57,181
		110,538		143,721
Grand total		1,253,959		1,895,912

[a] Onyx not separately classified after new tariff went into effect (Sept. 22, 1922), but included under "Marble."

[b] Quantity not given.

[1] The tables of exports and imports were compiled by J. A. Dorsey, of the United States Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Stone (including marble) exported from the United States in 1922.

Country.	Marble in blocks (rough or dressed).		Marble manufactures.		Other building or monumental stone.		Other manufactures of stone (including paving blocks and curbing).		Total value.
	Cubic feet.	Value.	Short tons.	Value.	Cubic feet.	Value.	Short tons.	Value.	
North America:									
British West Indies—									
Barbados			2	$600			3	$407	$1,007
Bermuda			(a)	879			1	365	1,244
Jamaica	6	$25	1	1,117			51	9,087	10,229
Trinidad and Tobago	75	491	14	6,364			2	266	757
Other	10	100					13	3,575	10,039
Canada	57,404	193,251	138	36,920	431,833	$348,740	43,145	441,829	1,020,740
Central America	154	394	24	3,509			38	8,978	12,881
Cuba	15,081	46,986	99	8,724	415	3,083	163	13,378	72,171
Dominican Republic	224	1,603	9	2,064			4	661	4,328
Dutch West Indies			(a)	152			1	116	268
French West Indies							(a)	5	5
Haiti	25	226	(a)	62	22	97	2	879	1,264
Mexico	3,985	1,570	48	6,582	(b)	(b)	272	34,993	b 78,459
Newfoundland and Labrador	1,361	6,073					19	3,157	9,230
Panama			9	6,372			24	3,306	9,678
Virgin Islands of the United States			1	171			2	469	640
	78,325	250,719	345	73,516	b432,270	b351,920	43,740	521,471	b1,232,940
South America:									
Argentina			(a)	149			7	1,137	1,286
Brazil			1	930			7	729	1,659
Chile			116	52,954			21	885	53,839
Colombia			1	1,228			28	8,537	9,765
Ecuador							7	1,052	1,052
Peru	90	3,587	16	5,650	19	400	4	1,182	10,819
Venezuela			1	448			3	747	1,195
Other South America			(a)	183			4	709	892
	90	3,587	135	61,542	19	400	81	14,978	80,507
Europe:									
France			(a)	100			29	8,124	8,224
Germany			(a)	65			21	14,816	14,881
Italy			1	168			(a)	4	172
Netherlands			(a)	5			154	20,675	20,680
Norway	250	260					(a)	158	418
United Kingdom—									
England	30	100	92	28,829	1,153	1,128	188	11,134	41,191
Scotland			3	2,788	12	64	26	2,970	5,822
Other Europe c							41	8,803	8,803
	280	360	96	31,955	1,165	1,192	459	66,684	100,191
Asia:									
British India			(a)	296			284	18,072	18,368
China	968	13,904	19	3,961			19	989	18,854
Dutch East Indies					151	95	72	10,699	10,794
Japan			14	3,449			191	12,561	16,010
Philippine Islands	6,467	24,090	22	8,868			29	3,629	36,587
Other Asia			9	5,253			8	2,734	7,987
	7,435	37,994	64	21,827	151	95	603	48,684	108,600
Africa:									
British South Africa			4	3,080			96	17,239	20,319
Other Africa			(a)	31			6	1,127	1,158
			4	3,111			102	18,366	21,477
Oceania:									
Australia			3	1,901			128	23,414	25,315
New Zealand	4	32					111	14,364	14,396
Other Oceania	10	45					9	1,289	1,334
	14	77	3	1,901			248	39,067	41,045
Grand total	86,144	292,737	647	193,852	b433,605	b353,607	45,233	709,250	b1,584,760

a Less than 1 ton.

b From "other building or monumental stone" is excluded by the Geological Survey, 2,064,421 cubic feet of stone, valued at $35,314, practically all shipped from Andrade, Calif., into Mexico for the protection of levees and other riprap work. The value of this material is, however, included in the total value for Mexico and in the grand total value.

c Includes Azores and Madeira Islands, Belgium, Denmark, Portugal, Spain, Sweden, and Switzerland.

General imports of marble and onyx, rough and manufactured, into the United States in 1921 and 1922.

Country.	1921				1922			
	Rough marble, breccia, and onyx.		Manufactured.	Total value.	Rough marble, breccia, and onyx.		Manufactured.	Total value.
	Cubic feet.	Value.			Cubic feet.	Value.		
Canada	.....	.....	$4,454	$4,454	119	$486	$6,833	$7,319
Cuba	22	$38	.....	38	32	78	442	520
Guatemala	.....	.....	.....	.....	1,045	6,612	.....	6,612
Mexico	2,245	9,191	137	9,328	6,550	37,020	5	37,025
Total North America	2,267	9,229	4,591	13,820	7,746	44,196	7,280	51,476
Belgium	15,298	26,822	10,840	37,662	65,169	146,292	5,790	152,082
France	16,962	42,740	43,067	85,807	17,905	40,302	19,514	59,816
Germany	4,842	5,279	6,815	12,094	1,461	1,057	16,207	17,264
Greece	2,221	8,281	.....	8,281	4,036	18,010	.....	18,010
Italy	348,307	725,687	115,841	841,528	455,335	918,856	250,269	1,169,125
Netherlands	1,044	1,734	94	1,828	.....	.....	.....	.....
Spain	.....	.....	2,082	2,082	.....	.....	1,505	1,505
England	.....	.....	4,682	4,682	.....	.....	6,228	6,228
Other Europe [a]	.....	.....	1,266	1,266	.....	.....	3,535	3,535
Total Europe	388,674	810,543	184,687	995,230	543,906	1,124,517	303,048	1,427,565
China	.....	.....	262	262	.....	.....	1,007	1,007
Japan	.....	.....	374	374	74	130	94	224
Other countries [b]	35	269	2,981	3,250	133	455	1,399	1,854
	35	269	3,617	3,886	207	585	2,500	3,085
Grand total	390,976	820,041	192,895	1,012,936	551,859	1,169,298	312,828	1,482,126

[a] 1921: Austria, Czechoslovakia, Norway, Sweden, Switzerland, and Scotland. 1922: Austria, Czechoslovakia, Denmark, Netherlands, Poland and Danzig, Sweden, Switzerland, and Scotland.
[b] 1921: Dominican Republic, Chile, Peru, Uruguay, British India, Dutch East Indies, Hongkong, and Palestine and Syria. 1922: Venezuela, British India, Hongkong, Palestine and Syria, Egypt, Algeria and Tunis, and Australia.

Value of building and monumental stone (exclusive of marble, onyx, and breccia) and other classes of stone imported into the United States in 1922.

[General imports.]

Country.	Building and monumental stone.	Other stone.	Total.
North America:			
Canada	$59,585	$46,118	$105,703
Mexico	815	.....	815
	60,400	46,118	106,518
Europe:			
Belgium	15	12,818	12,833
Czechoslovakia	2,777	.....	2,777
Denmark	1,802	.....	1,802
Finland	496	.....	496
France	7,586	14,443	22,029
Germany	40,399	21,582	61,981
Italy	57,644	5,828	63,472
Netherlands	188	14,337	14,525
Norway	7,463	459	7,922
Sweden	93,731	.....	93,731
United Kingdom—			
England	48,681	13,975	62,656
Scotland	119,048	1,355	120,403
Ireland	90	.....	90
Yugoslavia, Albania, etc	.....	7,265	7,265
Other Europe [a]	1,069	72	1,141
	380,989	92,134	473,123
Other countries [b]	3,034	981	4,015
Total imports	444,423	139,233	583,656

[a] Includes Austria, Hungary, Latvia, Portugal, and Spain.
[b] Includes British India, China, Hongkong, Japan, Palestine and Syria, and French Oceania.

The material classed as "Other stone" includes material not included in special classification, such as burrstone in blocks, rough or manufactured; quartzite; trap rock; rottenstone, tripoli, and sand, crude or manufactured; cliff stone, freestone, granite, and sandstone, unmanufactured and not suitable for building stone.

TARIFF ON STONE.

The tariff act of 1922 made some changes in the duty imposed on imported stone. The following table shows the duty prior to September, 1922, and the present duty:

Duty imposed on stone imported into the United States, prior to and after the tariff act of September, 1922.

Stone.	Former duty.	Present duty.
Marble, onyx, and breccia:		
In blocks, rough or squared only, per cubic foot	$0.50	$0.65
Sawed or dressed, do	.75	1.00
Slabs or tiles—		
Not more than 1 inch thick—		
Unrubbed, per superficial foot	.06	.08
Rubbed, do	.08	.11
More than 1 inch and not more than 1½ inches thick—		
Unrubbed, per superficial foot	.08	.10
Rubbed, do	.10	.13
More than 1½ inches and not more than 2 inches thick—		
Unrubbed, per superficial foot	.10	.13
Rubbed, do	.12	.16
Manufactured wholly or partly into monuments, benches, vases, and other articles of which marble, onyx, or breccia are the material of chief value	45%	50%
Mosaic cubes not exceeding 2 cubic inches in size—		
Loose, per pound	20%	½c.+20%
Attached to paper or other material, per superficial foot	35%	5c.+35%
Granite:		
Quarry blocks, rough, per cubic foot	.....	.15
Hewn, dressed or polished, per pound	.....	50%
Unmanufactured or not dressed, hewn or polished, per cubic foot	.03	.....
Hewn, dressed, polished or otherwise manufactured	25%	.....
Sandstone, limestone, freestone, lava, and other monumental or building stone not elsewhere specified:		
Quarry blocks, rough, per cubic foot	.....	.15
Hewn, dressed, or polished	.....	50%
Freestone, sandstone, limestone, lava, and all other monumental or building stone, except granite, marble, breccia, and onyx, not specially provided for:		
Unmanufactured or not dressed, hewn or polished, per cubic foot	.03	.....
Hewn, dressed, or polished or otherwise manufactured	25%	.....
Ballast	10%	(a)
Granite, sandstone, and freestone, unmanufactured and not suitable for use as monumental or building stone	Free.	Free.
Quartzite and trap rock	(a)	Free.
Limestone, not suitable for use as monumental or building stone, crude or crushed but not pulverized, per 100 pounds	(a)	.05

[a] Not so classified.

PRODUCTION BY KINDS AND STATES.

GRANITE.

GENERAL SUMMARY.

Granite as a whole showed an increase of 24 per cent in quantity but only 3 per cent in value in 1922 as compared with 1921, an increase in the quantity sold for rough construction and as crushed stone being partly offset by a decrease in the average value of some of the other grades of granite. The sales of different grades of granite for building are shown on page 266. They all increased in

quantity except cut architectural granite, which decreased 1 per cent. The total sales of granite for monumental work increased 7 per cent, owing to a small increase in sales of rough stock and an increase of 29 per cent in sales of dressed stone. The number of paving blocks sold decreased 31 per cent, and the sales of curbing and flagging increased 20 per cent. The output of dressed granite has been influenced during 1922 by a strike among quarrymen and granite cutters in various parts of the country, especially in the New England States. The agreement between the employers and employees was to be renewed in April, 1922, but differences in opinion between the different groups arose early in the year, and at the time set for signing the agreement they had not been adjusted to the satisfaction of either side, and a strike resulted. Some of the plants closed, but many decided to keep their shops and quarries open on the "American plan," which is practically the open shop. Some of the quarries and plants later signed the agreement with both the workers and the unions, but others have adhered to the original plan, so that there are in most districts plants working on both systems. The largest monumental center affected was Barre, Vt., where the production decreased 34 per cent. Practically nothing was done in several of the plants in New England where building stone is a major product. The "American plan" includes the training of apprentices to replenish the ranks of skilled workmen. Some of the quarrymen and cutters who were forced out of employment by the strike opened small quarries and plants and did their own work, and the totals for 1922 include small amounts of stone obtained in this manner. Crushed granite for road metal, for all kinds of concrete work, and for railroad ballast increased 32 per cent. Granite for riprap work increased 39 per cent, and granite for rubble decreased 4 per cent. Under "Other uses" is included 13,400 short tons of stone used in concrete stucco work, in which as a rule the color of the stone plays an important part.

Granite sold in the United States in 1921 and 1922, by uses.

Use.	1921		1922	
	Quantity.	Value.	Quantity.	Value.
Building stone (rough and dressed)....cubic feet..	4,051,650	$4,206,346	5,058,320	$4,247,131
Approximate equivalent in short tons....	336,500	.....	419,500	.....
Monumental stone....cubic feet..	1,956,720	7,253,276	2,085,740	7,429,332
Approximate equivalent in short tons....	161,230	.....	172,760	.....
Paving....number of blocks..	37,201,360	3,222,007	25,693,300	2,232,628
Approximate equivalent in short tons....	408,800	.....	269,550	.....
Curbing....linear feet..	1,171,990	857,799	1,407,760	900,101
Approximate equivalent in short tons....	72,790	.....	87,340	.....
Rubble....short tons..	182,730	219,129	174,740	221,264
Riprap....do....	469,250	269,159	652,210	480,826
Crushed stone....do....	3,096,410	4,447,087	4,096,910	5,415,076
Other stone....do....	24,470	117,414	40,110	199,511
Total (quantities approximate, in short tons)....	4,752,180	20,592,217	5,913,120	21,125,869

Granite sold in the United States in 1921 and 1922, by States.

[Quantities approximate.]

State.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
Arizona	150,730	$46,957	213,770	$50,585
Arkansas	22,030	33,544	19,140	23,563
California	1,406,760	1,910,345	1,885,600	2,878,708
Colorado	2,670	146,380	1,880	132,730
Connecticut	11,060	193,599	17,830	211,301
Delaware	(a)	(a)	(a)	(a)
District of Columbia	12,360	12,087	11,110	18,658
Georgia	189,420	1,023,081	221,260	1,057,823
Idaho	41,800	57,500	(a)	(a)
Maine	163,240	1,386,660	146,450	1,803,473
Maryland	139,450	348,262	195,200	383,868
Massachusetts	387,410	2,619,266	464,500	2,519,832
Minnesota	77,650	1,292,650	111,680	2,085,880
Missouri	12,010	81,389	12,970	85,093
Montana	400	19,706	910	57,393
New Hampshire	87,460	1,322,277	116,960	1,048,339
New Jersey	79,540	115,102	(a)	(a)
New York	62,750	232,190	117,800	370,471
North Carolina	645,310	1,899,597	835,950	2,325,940
Oklahoma	1,210	53,486	20,520	121,478
Oregon	(a)	(a)	(a)	(a)
Pennsylvania	125,150	330,301	231,450	577,443
Rhode Island	49,840	424,959	36,730	284,122
South Carolina	427,140	882,267	638,400	1,175,049
South Dakota	15,890	117,688	10,800	84,954
Texas	7,960	131,396	9,430	110,453
Utah			(a)	(a)
Vermont	82,500	3,835,771	55,710	1,679,986
Virginia	140,800	175,812	162,420	178,889
Washington	3,720	29,551	72,470	184,435
Wisconsin	316,650	1,706,095	157,050	1,414,430
Undistributed	89,270	164,299	145,130	260,973
	4,752,180	20,592,217	5,913,120	21,125,869

a Included under "Undistributed."

Granite sold in the United States in 1922, by States and uses.

State.	Number of active plants.	Building.						Monumental.				Paving blocks.	
		Rough construction.		Rough architectural.		Dressed architectural.		Rough.		Dressed.			
		Short tons.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Number.	Value.
Arizona	3									(a)	(a)		
Arkansas	4	(a)	(a)					(a)	(a)				
California	41			2,140	$4,946	141,090	$782,429	83,590	$78,446	44,600	$274,360		
Colorado	9							10,810	27,010	11,510	105,720		
Connecticut	13	(a)	(a)	3,050	3,423	5,210	22,116	b 27,440	b 128,406	(b)	(b)	196,750	$17,263
Delaware	2												
District of Columbia	5												
Georgia	24			(c)	(c)	c 61,200	c 262,037	50,240	82,783	18,180	146,460	2,743,620	177,543
Idaho	1												
Maine	46	2,270	$4,617	407,870	415,320	67,820	516,581	65,410	95,871	11,680	36,199	7,327,990	656,615
Maryland	8	85,850	152,400	(a)	(a)			(a)	(a)	(a)	(a)	(a)	(a)
Massachusetts	56	27,970	52,602	133,410	147,736	131,200	529,628	260,940	473,944	11,620	106,467	3,340,450	383,130
Minnesota	32					48,930	249,665	98,190	237,642	202,180	1,434,450	(a)	(a)
Missouri	7							11,810	42,131			338,870	30,498
Montana	6					(a)	(a)	b 2,440	b 13,556	(b)	(b)		
New Hampshire	26	1,900	2,826	26,680	34,149	26,230	217,127	49,440	91,135	36,330	288,595	2,965,990	216,456
New Jersey	2	(a)	(a)										
New York	18	3,650	5,477	19,490	17,199	10,600	48,750	b 16,500	b 44,968	(b)	(b)	(a)	(a)
North Carolina	24			b 89,930	b 230,840	(b)	(b)	(a)	(a)	(a)	(a)	3,671,210	266,229
Oklahoma	6	(a)	(a)	(a)	(a)	(a)	(a)	(c)	(c)	c 11,100	c 89,056		
Oregon	2							(a)	(a)	(a)	(a)		
Pennsylvania	34	158,460	291,240	b 84,480	b 56,244	(b)	(b)	10,670	24,032	16,150	101,892	79,610	5,763
Rhode Island	10	60	90	b 1,180	b 3,215	(b)	(b)	b 64,290	b 192,419	(b)	(b)	(a)	(a)
South Carolina	12	(a)	(a)					(a)	(a)			(a)	(a)
South Dakota	3									(a)	(a)		
Texas	10			370	349			45,550	103,726				
Utah	1			(a)	(a)			(a)	(a)				
Vermont	32	(a)	(a)	(a)	(a)			b 602,650	b 1,670,620	(b)	(b)	(a)	(a)
Virginia	7			2,670	4,001			570	1,000				
Washington	5					(a)	(a)	(c)	(c)	c 7,900	c 25,007		
Wisconsin	20	14,710	12,187					22,270	43,425	74,600	946,215	3,290,290	284,581
Undistributed	.....	16,130	28,808	25,780	28,196	22,250	122,933	176,460	217,138	40,620	306,659	1,738,520	194,550
	469	311,000	550,247	791,610	778,366	519,970	2,918,518	1,572,140	3,272,576	513,600	4,156,756	25,693,300	2,232,628
Average value	.....	.....	1.77	.....	0.98	.....	5.61	.....	2.08	.....	8.09	.....	d 86.90

State.	Number of active plants.	Curbing.		Rubble.		Riprap.		Crushed stone.				Other uses.		Total.	
								Concrete and road metal.		Railroad ballast.					
		Linear feet.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
Arizona	3					(a)	(a)	(a)	(a)	(a)	(a)			213,770	$50,585
Arkansas	4			11,790	$9,111			(a)	(a)					19,140	23,563
California	41	1,970	$9,551	9,000	1,351	252,790	$197,194	1,376,640	$1,372,783	223,790	$154,548	1,000	$3,100	1,885,600	2,878,708
Colorado	9													1,880	132,730
Connecticut	13	13,880	17,487	(a)	(a)	(a)	(a)	1,000	1,000			1,530	1,208	17,830	211,301
Delaware	2							(a)	(a)					(a)	(a)
District of Columbia	5	510	425	11,090	18,233									11,110	18,658
Georgia	24	475,020	220,487	52,380	48,246	(a)	(a)	95,890	115,527	1,400	1,640	2,100	2,500	221,260	1,057,823
Idaho	1							(a)	(a)					(a)	(a)
Maine	46	69,930	64,015			9,400	6,426	3,850	6,110	540	519	3,260	1,200	146,450	1,803,473
Maryland	8			(a)	(a)	(a)	(a)	41,190	71,217	(a)	(a)			195,200	383,868
Massachusetts	56	248,510	237,866	63,010	94,018	6,840	7,015	270,430	484,385	1,180	2,366	450	675	464,500	2,519,832
Minnesota	32			(a)	(a)			77,410	131,719			(a)	(a)	111,680	2,085,880
Missouri	7					(a)	(a)	(a)	(a)					12,970	85,093
Montana	6	(a)	(a)									(a)	(a)	910	57,393
New Hampshire	26	112,950	84,517	(a)	(a)	(a)	(a)	55,460	100,031	1,300	1,374	(a)	(a)	116,960	1,048,339
New Jersey	2							(a)	(a)					(a)	(a)
New York	18			(a)	(a)	(a)	(a)	28,690	34,532	19,810	16,196	(a)	(a)	117,800	370,471
North Carolina	24	451,650	251,149	(a)	(a)	13,350	9,151	724,750	1,156,183			11,490	102,419	835,950	2,325,940
Oklahoma	6							(a)	(a)					20,520	121,478
Oregon	2													(a)	(a)
Pennsylvania	34	(a)	(a)	(a)	(a)	(a)	(a)	47,740	75,093	(a)	(a)	2,320	3,036	231,450	577,443
Rhode Island	10	(a)	(a)	(a)	(a)			30,680	84,769					36,730	284,122
South Carolina	12	27,960	8,919	950	1,601	(a)	(a)	531,200	862,597	86,600	105,509			638,400	1,175,049
South Dakota	3					(a)	(a)	(a)	(a)					10,800	84,954
Texas	10	(a)	(a)			(a)	(a)					520	1,424	9,430	110,453
Utah	1													(a)	(a)
Vermont	32	(a)	(a)			(a)	(a)							55,710	1,679,986
Virginia	7			2,250	4,500	10,000	20,000	62,900	78,788	87,000	70,600			162,420	178,889
Washington	5			(a)	(a)	(a)	(a)					(a)	(a)	72,470	184,435
Wisconsin	20	1,210	1,326	7,840	5,644			87,190	102,609			4,700	18,443	157,050	1,414,430
Undistributed		4,170	4,359	16,430	38,560	359,830	241,040	179,230	296,303	61,040	88,678	12,740	65,506	145,130	260,973
	469	1,407,760	900,101	174,740	221,264	652,210	480,826	3,614,250	4,973,646	482,660	441,430	e 40,110	e 199,511	5,913,120	21,125,869
Average value			0.64		1.27		0.74		1.38		0.91		4.97		3.57

a Included under "Undistributed."
b Dressed stone included under rough stone.
c Rough stone included under dressed stone.
d Per M.
e Includes 10,100 tons of durax paving blocks, valued at $100,609, made in Maine, North Carolina, and Wisconsin.

PRODUCING LOCALITIES.

The following paragraphs contain a short review of the different granite-producing localities and the character of the product obtained from them, as well as the names of the producing firms. The review is given with special reference to building and monumental stone, but the other uses of the stone are also noted. Under granite are included syenite, monzonite, and diorite, which are commercially classified as granite. It also includes the gabbro and diabase which are sold under the name "black granite." The references to color and grain of the stone are derived either from information reported by the operator of the quarry or from geologic reports or other reliable sources. The trade names of the stone from the different quarries are mostly derived from the advertisements of the different companies, and the names of the structures in which the stone is used from the producers themselves or from descriptive matter relating to the structures. The relative importance of any branch of the industry in any State may be obtained by a study of the table of production (pp. 274–275).

NEW ENGLAND STATES.

The New England States furnished about 14 per cent of all the granite sold in 1922. The value of the granite sold from these States, however, was 36 per cent of the total value for the United States. The granites of the New England States are described in a recent report.[2] Lists of the producers active in 1922 and their principal products are given below by States.

Maine.—The granite quarried in Maine is used chiefly for building, monuments, paving blocks, and curbing, only a very small part of the product being sold as riprap, crushed stone, and for other uses, and for this reason the granite output of this State has a higher average unit value than that of many other States whose output is larger. Operations in the Maine quarries were curtailed in 1922 by granite cutters' strikes, and some plants were idle or running on a very small scale. Operations at Hallowell and Stonington by the George A. Fuller Co. in the production of stone for the erection of the court house in New York City (basement Hallowell, superstructure Stonington) helped materially to keep up the production of the State.

Several small operators opened quarries in 1922 and sold rough stock for monument bases. A market for this stone was created this year because the operators of large quarries and manufacturing plants, on account of strikes of quarrymen and cutters lasting from April until September, were unable to supply the usual amount of either rough or manufactured product. Also it was possible for strikers who owned or could lease small quarries to set up in business for themselves and supply local demand for small work.

The quarries active in 1922 were as follows:

Cumberland County:
  Westbrook: James H. Pride; fine-grained gray granite; rough monumental, curbing.
Franklin County:
  North Jay: Maine & New Hampshire Granite Co.; "North Jay White"; fine-grained light-gray granite; buildings, monuments, mausoleums, paving blocks, curbing, riprap, crushed stone.

[2] Dale, T. N., The commercial granites of New England: U. S. Geol. Survey Bull. 738, 1923.

Hancock County:
East Franklin: T. M. Blaisdell; medium-grained dark-gray granite; paving blocks, curbing.
Franklin:
H. P. Blaisdell; fine-grained gray granite; riprap.
W. B. Blaisdell & Co.; medium-grained gray granite; paving blocks, curbing.
Bradbury, Blaisdell & Smith; monuments.
Bradbury & Orcutt; fine-grained gray granite; monument bases, paving.
S. A. Bragdon; monument bases.
M. S. Butler; monument bases, paving blocks.
J. M. Clark & Son; monument bases.
C. L. Coombs & Sons; monument bases.
Gay & Springer; monument bases.
Tyler A. Gordon, Goodwin quarry; monument bases.
Hutchins & Goodwin; monument bases, paving blocks.
Springer, Colson & Joy, Fred E. Blaisdell quarry; monument bases.
Franklin and Sullivan: Arno Wooster; paving blocks.
Hall Quarry:
Booth Bros. & Hurricane Isle Granite Co. (address, New York, N. Y.), Somes Sound quarry; coarse to medium-grained light buff-gray granite; rough building, rough monuments, paving blocks.
Mount Desert Granite Co.; paving blocks.
North Sullivan:
Harvey E. Robertson; coarse to medium-grained gray granite; rough monumental, monument bases, paving blocks, curbing.
R. F. Stanley, Newman quarry; monument bases.
Webb & Staples Co., Benvenue quarry; monument bases.
Stonington:
John L. Goss Corporation, Crotch Island quarry; coarse even-grained medium-gray granite, with lavender tint; buildings, monuments.
Rodgers Granite Corporation and George A. Fuller Co. (address, New York City), Settlement quarry; coarse-textured, slightly lavender-tinted medium-gray granite, with cream-white blotches; rough and dressed building, rough construction, riprap.
Sullivan:
Dunbar Bros., Whaleback quarry; coarse to medium-grained gray granite; paving blocks, curbing.
H. H. Havey & Co.; fine to medium-grained gray granite; paving blocks, curbing.
West Sullivan: E. C. Gordon; monument bases, paving blocks, curbing.
Kennebec County:
Hallowell: Hallowell Granite Works (address, Augusta) and George A. Fuller Co. (address, New York City); "Hallowell granite," fine-grained light-gray granite; rough construction, rough and dressed building, monumental, paving blocks.
Knox County:
Long Cove: Booth Bros. & Hurricane Isle Granite Co. (address, New York City); fine to medium-grained bluish-gray granite; rough monuments, paving blocks.
Rockland: John Meehan & Son (address, Philadelphia, Pa.), Clark Island quarry; paving blocks.
St. George: St. George Granite Co. (address, New York City), Willards Point quarry; fine to medium-grained bluish-gray granite; paving blocks.
South Thomaston: Bassick Bros. & Son; monuments, paving blocks.
Vinalhaven:
J. Leopold & Co. (address, New York City), East Boston quarry; paving blocks, durax blocks.
Roberts Harbor Granite Co. (address, New York City), Pequoit quarry; fine, even-grained gray granite; paving blocks.
Lincoln County:
Bristol: Peter Svenson, Round Pond quarry; fine-grained dark-gray granite; monuments, paving blocks.
Waldo County:
Lincolnville: W. E. Doran & Son; "Lincolnville gray," fine to medium-grained light-gray granite; monuments.

Washington County:
Addison: Maine Black Diamond Granite Co. (address, Frank Lang, Maspeth, N. Y.); "black granite" (gabbro); monuments.
Calais: C. L. Young; "black granite"; monuments.
Marshfield: Butler & Berry (address, Machias), Red Hill quarry; fine-grained pinkish-gray granite; monuments.
Millbridge: L. N. Burgess (address, Harrington), "Back Bay Pink" quarry; monuments, building.
Red Beach:
Red Beach Granite Co.; "black granite" (norite); monuments.
C. D. Young & Son; "black granite"; monuments.
York County:
Biddeford:
Frank Morin; coarse-grained light-gray granite; rough construction, monuments.
George H. Yates; coarse-grained light-gray granite; monuments.
North Berwick: Miniutti Bros. (address, Concord, N. H.); "North Berwick black granite" (gabbro); monuments. Idle in 1922.

New Hampshire.—Granite from New Hampshire is sold chiefly for building and monumental stone, paving blocks, and curbing. The active operators in 1922 were as follows:

Carroll County:
Redstone: Maine & New Hampshire Granite Co. (address, North Jay, Maine); coarse, even-grained light pinkish-gray granite with large dark-gray and small black spots, "Conway Pink"; coarse, even-grained, yellowish-green granite with black spots, "Redstone Green"; buildings, polished columns, and memorials. On account of the granite cutters' strike the quarries were practically idle all of 1922. In 1921 stone was furnished for the Wilmington Institute Press Library, Wilmington, Del., and for an addition to Syria Temple, Pittsburgh, Pa.
Cheshire County:
Fitzwilliam: Milford Pink-Victoria White Granite Co. (address, Milford, Mass.); fine-grained light bluish-gray granite, "Victoria White," "Snow Flake"; rough and dressed building and monuments.
Fitzwilliam Depot:
E. M. Thompson; fine even-grained light-gray granite; monuments.
Edw. Yon & Son; light bluish-gray granite, "White Granite"; monuments, curbing.
Marlboro: Hildreth Granite Co. (address, Boston), Webb quarry; paving blocks.
Hillsborough County:
Brookline: Sneck & Mahoney; paving blocks.
Manchester (near): Vogel & Hadley; crushed stone.
Milford. The granite quarried at Milford is in general fine, even-grained gray granite of light to dark shades, some of it with a slight bluish, pinkish, or buff tinge. It is spangled with black mica and is known to the trade as "Milford granite."
Blue Quarry Co.; monuments.
Bowler & Son; monuments.
O. A. Ciampa, Ball Hill quarry; paving blocks, monuments.
E. L. Kittredge; buildings, monuments, paving blocks, curbing.
Lovejoy Granite Co.; buildings, monuments, paving blocks, curbing, riprap.
New Westerly Granite Co.; "New Westerly Blue"; monuments.
Pease Co. (address, Nashua); buildings, monuments, paving blocks, curbing.
Roberts Bros.; monuments, paving blocks.
Smalley Souhegan Granite Co.; monuments, paving blocks.
Tonella & Sons, King and Queen quarries; monuments, paving blocks, riprap.
North Brookline: Crown Hill Quarry Co. (address, Milford); monuments, paving blocks.
South Brookline: John A. Richards; "Brookline Blue"; monuments.

Merrimack County:
Concord. The granite quarried at Concord, known to the trade as "Concord granite," is a medium bluish-gray granite of fine to medium even texture.
Granite State Quarries Co., Rattlesnake Hill quarry; monumental.
La Pierre Bros.; rough and dressed monumental.
Perry Bros.; rough and dressed monumental, building, paving blocks. Stone from this quarry was used in 1922 in the construction of the Detroit Life Insurance Co. building, Detroit, Mich.; the Prince district school and police and fire station No. 31, Boston; the Theodore Roosevelt School, Roxbury, Mass.; and the Washington Allston district school, Brighton, Mass.
Potter Bros. & Sons, Blue Swamp quarry; rough building, rough monumental.
John Swenson Granite Co.; rough and dressed building, rough and dressed monumental, paving blocks, curbing, flagging, ashlar. In 1922 stone was furnished for the Rhode Island State Prison and Providence County jail at Howard, R. I., and the Jefferson Avenue Bridge, Detroit, Mich.
Suncook: Charles A. Bailey; even-grained light-gray granite, "Allenstown granite"; rough construction, buildings, paving blocks, curbing, crushed stone.

Vermont.—The granite produced in Vermont has included both monumental and building stone, with a small amount of stone for miscellaneous uses. Owing to labor and other industrial conditions practically no building stone was sold in this State in 1922, and the output of monumental stone was greatly curtailed. The total sales decreased 32 per cent in quantity and 56 per cent in value, after decreases of 35 per cent and 20 per cent, respectively, in 1921. The greater decrease in value than in quantity in 1922 was due, first, to the somewhat lower prices in that year than in 1921, and second, to the fact that no dressed building stone was sold in 1922. The principal quarry centers are the Barre district for monumental stone and the Woodbury and Bethel districts for monumental and building stone. These districts are mainly in Washington County. The Bethel district was idle in 1922. Other districts active in 1922 were Groton, Hardwick, Morgan Center, Newport, Orleans, South Ryegate, and West Dummerston, chiefly for monumental stone. Granite has also been produced in other localities but chiefly for local markets. Details concerning some of the districts are given under the respective counties in the following list of operators in 1922:

Caledonia County. The granites from Hardwick and South Ryegate are fine to medium, even-grained bluish-gray granites and are known to the trade as "Hardwick," "Dark-Blue Hardwick," "Ryegate," "Vermont Gray," and "Vermont Blue."
Groton: Bonazzi Quarry Co. (Inc.) (address, Montpelier); blue-gray granite, "Vermont Blue;" monuments.
Hardwick:
August Ahonen; monuments.
Frank V. Gonyear; monuments.
George Y. Ralph, Buck Lake quarry; monuments.
South Ryegate:
Beaton Bros. Quarry Co. (Inc.); monuments.
New Barre Granite Co.; monuments.
Rosa Bros.; "Vermont Gray"; monuments.
Ryegate Granite Works; "Ryegate"; monuments.
Essex County:
Morgan Center: W. H. Parmenter; monument bases.
Orange County. See Washington County.

Orleans County:

Newport: A. L. Lacasse Granite Co.; even, medium to fine grained light bluish-gray granite, "Derby Gray"; monuments.

Orleans: O. L. Searles; monument bases.

Washington and Orange counties. The Barre district, which is the most important center in the State, includes Barre, East Barre, Graniteville, Montpelier, Northfield, Waterbury, Websterville, and West Berlin, Washington County, and Williamstown, Orange County. The city of Barre is the center for the manufacturing plants. The monumental industry in this district is composed of two distinct parts, the quarry industry and the manufacturing industry. Except those of the Jones Bros. Co. practically all quarry operations are separate from manufacturing plants, the quarries furnishing rough stone for the consumption of the manufacturing plants in the neighborhood and also for shipment to all parts of the country.

The figures compiled by the Geological Survey represent quarry output only and include only such manufactured stock as the quarrier of the stone manufactures from his own product. The output for the Barre district for 1918–1922, as reported by the quarrymen to the Geological Survey, has been as follows:

Monumental granite sold by the quarrymen in the Barre district, Vt., 1918–1922.

Year.	Cubic feet.	Value.
1918	1,369,000	$2,308,757
1919	1,376,000	3,623,055
1920	1,147,800	3,957,881
1921	686,947	2,417,024
1922	453,000	1,395,911

Through the kindness of Mr. R. E. Mitchell, secretary of the Barre Granite Manufacturers Association, the following figures covering the entire granite industry at Barre, are given to supplement the figures of production reported to the Geological Survey by the quarrymen:

Estimated output of monumental granite in Barre district, 1918–1921.

	1918	1919	1920	1921
Total quarry output, rough stock ..... cubic feet..	1,654,800	1,273,650	1,178,442	474,000
Shipped out of Barre district in rough ..... cubic feet..	248,222	191,048	176,766	71,100
Manufactured in Barre district ...do....	1,406,578	1,082,602	1,001,676	402,900
Light stock consumed in district..do....	879,111	676,626	626,048	251,813
Dark stock consumed in district..do....	527,467	405,976	375,628	151,087
Number of cutters in district	1,500	1,500	1,400	1,100
Average daily wage	$5.00	$6.00	$7.20	$8.00
Average number of days worked	260	280	230	160
Total pay roll for year	$1,950,000	$2,520,000	$2,318,400	$1,408,000
Estimated overhead	975,000	1,260,000	1,159,200	704,000
Estimated value of light stock	1,572,400	2,435,854	2,253,773	906,527
Estimated value of dark stock	1,054,934	1,664,502	1,540,075	619,457
Estimated polishing cost	900,000	1,050,000	600,000	300,000
Output from saws	500,000	350,000	200,000	100,000
Total value of granite	6,752,334	9,280,356	8,071,448	4,037,984

Figures for 1922 are not yet available. The decline in quantity in 1921 reflects the shortage of buyers' money as compared with 1919 and 1920 and also the effect of the labor unrest that began in 1921 and culminated in a general strike among the quarrymen and cutters early in 1922 and lasted throughout the year. Mr. Mitchell also makes the following statement regarding the situation in the Barre district:

"The years 1919 and 1920 were normal years notwithstanding there was a strike which resulted in a complete shutdown for 10 weeks

during 1920. The year 1921 was a period of depression in this business. In fact, many of our manufacturers closed their plants in the late fall of 1920, not to reopen them until well into 1922, and in some cases not until 1923. Then in the early part of 1922 a serious labor difficulty resulted in an open-shop declaration on the part of a great majority of manufacturers and quarry owners. Inasmuch as very few of the union men returned to work under open-shop conditions, the change entailed the employment of largely inexperienced men, a factor which naturally cut down production. At the present time a respectable number of manufacturers are once more operating on the union basis, while a majority of the others are adhering to the American plan or open shop. The union manufacturers have skilled mechanics at their disposal. American-plan manufacturers, on the other hand, are now beginning to get efficiency out of their employees, and so between the two groups production in both the quarries and the cutting plants will be far larger in 1923 than during the previous two years. It may even approach the production of 1919 and 1920."

The "Barre granite" is a fine to medium grained bluish-gray stone, which, according to the shades of gray in which it occurs, is known to the trade as "dark Barre," "medium Barre," "light Barre," "very dark Barre," and "white Barre." The dark shades are most in favor for monumental stone, and the lighter stone is used for construction. Many of the operators have all the different varieties in their quarries.

The quarry operators in the Barre district in 1922 were as follows:

Barre (Washington County):
- Boutwell, Milne & Varnum Co. (address, Montpelier), Rock of Ages quarry; monuments.
- E. L. Smith & Co.; monuments.
- Wetmore & Morse Granite Co. (address, Montpelier); monuments.

Montpelier (Washington County): Alton H. Sloane; rough monumental.

Websterville (Washington County):
- Barre Granite Quarrying Co. (address, Barre); monuments.
- Capitol Hill Granite Co. (Inc.) (address, Montpelier); monuments, paving blocks.
- Littlejohn & Milne Quarry Co. (Inc.) (address, Barre); monuments.
- Standard Granite Co. (address, Barre); monuments.
- Wells-Lamson Quarry Co. (address, Barre); monuments.

Williamstown (Orange County):
- Jones Bros. Co. (address, Barre); monuments.
- James K. Pirie Estate (address, Barre); monuments.
- Williamstown Quarry Co.; monuments.

The principal quarries in Vermont furnishing building stone—those at Bethel and Woodbury—were idle in 1922 on account of labor difficulties. It is stated that the strike which ended the last week of 1922 and which affected the Vermont quarries more than those of any other State was settled with the men belonging to the union on a wage scale of $1 an hour, the same that prevailed in 1921, and with important concessions made by the men to the employers in the way of provision for overtime without the necessity of referring to the union headquarters for approval; a decided extension of the apprentice clauses, permitting more apprentices in each branch of the industry; and liberal modifications of previous sharp restrictions in regard to the use of machinery. Those prominent in supplying building granite to the trade consider that the strike was most disastrous in its final results to both the granite producers and the workmen, and that inasmuch as the costs of production had already restricted the market it will be long before the industry recovers. The production of granite is a slow process, and a wage scale of $1 an hour to a granite cutter means a very high cost per cubic foot produced, so that competing materials have a wider margin under the cost of granite than ever before, and the amount of high-grade granite used in the country for building is bound to decrease.

The Woodbury granite is fine to medium grained and ranges in color from dark to light gray. It is known to the trade as "Woodbury

Gray," "Imperial Blue," "Woodbury Bashaw," and "Vermont White." The stone is used for both monuments and buildings and in 1921 was used in the Case Technical High School, Detroit, Mich.; the First Lutheran Church, Johnstown, Pa.; and the Ashmore Mausoleum, Zanesville, Ohio.

The principal operators in the Woodbury and near-by districts in Washington County in 1922 were:

Adamant:
Hood Bros.; monuments.
Steele Quarry Co. (Inc.) (address, Barre); monuments.
Cabot: Joseph Lambert, Cabot Granite Co. (address, Hardwick); markers.
Calais: Hughes Granite & Quarry Co. (address, Montpelier); monuments.
Woodbury:
E. R. Fletcher; monuments, buildings.
L. S. Robie; monuments.
Woodbury Granite Co.; buildings, monuments.

Windham County:
West Dummerston: Presbrey-Leland Quarries (Inc.) (address, Brattleboro); "Dummerston White," even-grained, medium-textured light-gray granite speckled with bronze-colored mica; monuments, paving blocks, curbing, riprap. Furnished stone for Soldiers' Monument, Arlington, N. J., in 1922.

Windsor County. The quarry of the Woodbury Granite Co. (address, Hardwick), at Bethel, was idle in 1922 but in 1920–1921 furnished stone for the Telephone & Telegraph Building, New York City. The granite of this quarry, known as "Bethel White," is a coarse to medium grained bluish-white stone with black or grayish spots.

Massachusetts.—Massachusetts is one of the principal States producing granite for building and monumental work and produces a greater total quantity than any other of the New England States. The granite of Massachusetts is especially well known, and the "Quincy," "Milford," and "Rockport" stone has been shipped widely throughout the country and used in many important buildings and monuments. In 1922 Massachusetts, with the other granite-producing States, suffered from the strikes of quarrymen and stonecutters. The chief granite centers are in Essex, Middlesex, Norfolk, Bristol, and Worcester counties, but many other counties contain active quarries. The operators of active quarries in Massachusetts in 1922 and their products were as follows:

Berkshire County:
Becket: Chester Granite Quarries (Inc.) (address, Chester); fine-grained dark bluish-gray granite, "Chester Light," "Chester Dark"; monuments.

Bristol County:
Acushnet: Blue Stone Quarry Co. (Inc.) (address, New Bedford); crushed stone.
Dartmouth: North Dartmouth Granite Co. (address, New Bedford); medium to coarse grained light buff-gray gneissoid granite; rough construction, curbing.
Fall River:
Carey Quarry & Construction Co.; "Fall River Gray," light-gray coarse to medium grained gneissoid granite; rough construction, buildings, curbing.
Fall River Granite & Quarry Co.; light-gray gneissoid granite; rough construction, paving blocks, curbing.
New Bedford:
Fall River Cement Construction Co. (address, Fall River); crushed stone.
Roger Fay, Rolling Rock quarry; monuments, buildings, curbing, crushed stone.
Sullivan Granite & Construction Co.; light pinkish-gray coarse to medium grained gneissoid granite; rough and dressed construction, paving blocks, curbing, riprap, crushed stone.

Essex County:
Gloucester (see also Rockport): Cape Ann Granite Corporation. On account of the strike this quarry was idle in 1922, but sales of paving blocks were reported.
Lawrence:
Holland Construction Co.; crushed stone.
M. O'Mahoney Co.; crushed stone.
Newburyport: City of Newburyport, O'Neil quarry; crushed stone.
Rockport: J. Leonard Johnson (address, Pigeon Cove); medium to coarse grained gray granite with inconspicuous black spots; rough construction, paving blocks.
Rockport and Gloucester: Rockport Granite Co.; medium to coarse grained gray granite, spotted with black ("Rockport Light Gray" and "Bayview Gray") and dark olive-green granite spotted with black ("Sea-green"); rough construction, rough and dressed monumental, rough and dressed building, paving blocks, curbing, rubble, and crushed stone. Although the operations of the quarries and manufacturing plant of this company were greatly curtailed on account of a strike from April 1, 1922, to February 5, 1923, work was carried on under open-shop conditions from April 17 to December 21, 1922, and stone was furnished for such important structures as the Mellon National Bank, Pittsburgh, Pa.; Federal Reserve Bank, New Orleans, La.; Farmers & Merchants Bank, Tyrone, Pa.; and Beacon Trust Co. building, Boston, Mass.
Hampden County:
Monson: William N. Flynt Granite Co.; fine-grained dark-gray gneiss; buildings, curbing.
Middlesex County:
Acton: North Acton Quarry Co. (address, North Acton); fine-grained light bluish-gray gneiss, "Acton" granite; buildings, paving blocks.
Graniteville:
Charles E. Couture, Wright's quarry; fine to medium grained gray gneissoid granite; paving blocks, curbing, rubble.
H. N. Fletcher; fine to medium grained gray gneiss.
L. P. Palmer & Sons; fine to medium grained gray gneissoid granite; buildings, paving blocks, curbing, crushed stone.
Groton: Groton Granite Co. (address, Boston); medium to coarse light-gray granite gneiss; paving blocks.
Lowell:
Frank A. Mallory, Fletcher quarry; blue-gray gneiss; paving blocks, curbing.
George A. Morris (address, North Chelmsford); rough construction, paving blocks, curbing.
North Chelmsford: Orin O. Luke (address, West Chelmsford); blue-gray gneiss; paving blocks.
Westford:
Elisha Brake & Son (address, Tyngsboro); blue-gray gneiss, "Oakhill" granite; curbing.
C. W. Carkins (address, North Chelmsford); light bluish-gray gneiss; paving, curbing.
Arthur DeCarteret (address, Tyngsboro), Prescott quarry; blue-gray gneiss; curbing.
H. E. Fletcher Co. (address, West Chelmsford); light bluish-gray gneissoid granite, "Oakhill" granite; rough and dressed building, monuments, paving blocks, rubble, crushed stone. On account of quarry and cutter strikes from April 1 to August 1, 1922, the quarry was operated as an "open shop" and furnished granite for the Atlantic City High School, Atlantic City, N. J.; Covington Telephone Exchange Building, Covington, Ky.; dairy building and administration building, Shawsheen Village, Mass.; and Western Junior High School, Boston.
Thomas J. Le Masurier (address, Tyngsboro); light bluish-gray gneiss, "Oakhill" granite; curbing.

Middlesex County—Continued.

West Townsend: Duncan Rust, Barker Hill quarry; medium to fine grained, very light buff-gray granite, "West Townsend White"; medium to fine-grained light pinkish-gray granite, "West Townsend Red"; rough and dressed building, rubble. In 1922 this quarry was free from strikes and furnished stone for the Teachers College Library, New York City; St. Paul's Church, Newburyport, Mass.; Tabernacle Church, Salem, Mass.; and Lady of Our Saviour Church, Hartford, Conn.

Norfolk County:

Cohasset: Louis C. Tiffany quarries; mottled yellowish-gray granite, coarse texture; monuments, memorials, and church interiors.

Quincy and West Quincy. The granite quarried at Quincy is sold chiefly as rough monumental stone to manufacturers, who distribute it to all parts of the United States. The stone is medium to coarse grained, and the color varies from a light greenish-gray ("Extra Light," "Pea-Green"), used principally for construction work, to a very dark gray or dark bluish or purplish gray, with black crystals (aegirite and riebeckite), used for the highest class of monumental work. The stone contains no mica. The trade names for the different varieties of monumental granite are "Quincy Medium," "Quincy Dark," "Quincy Extra Dark," and "Gold Leaf"; the last is the lightest monumental stone sold and is characterized by yellowish and reddish specks of iron oxide, derived in part at least by oxidation of the unusual mineral aenigmatite. "Quincy Extra Light" is used for construction. Unsettled labor conditions, especially among the granite cutters at the manufacturing plants, and strikes of men at the quarries prevailed in this district in 1922, but on the whole it did not appear to suffer so severely as some of the other centers. The output of granite at the Quincy quarries from 1916 to 1922 has been as follows:

Year.	Number of active plants.	Short tons (approximate).	Value.
1916.....	10	62,000	$460,203
1917.....	10	20,000	398,196
1918.....	5	26,000	336,843
1919.....	8	32,000	614,005
1920.....	8	27,000	674,233
1921.....	6	14,000	311,178
1922.....	6	16,000	341,601

Elkhill & Bishop, Wilson quarry.

Falconer & Co., McKenzie & Pattison quarries.

Granite Railway Co. (address, West Quincy), Granite Railway quarries.

C. H. Hardwick & Co.

Old Colony Crushed Stone Co.; crushed stone.

Quincy Quarries Co., Hitchcock quarries.

J. S. Swingle (address, West Quincy), Badger (Wigwam), Elcock, Mannex, "Syenite Blue," and "light" quarries.

Stoughton: Messer Bros. (address, Brockton); coarse-grained gray granite; local building.

Weymouth. Seam-face granite, in which the walls of closely spaced joints are stained yellow and brown, is quarried in Weymouth and also in Plymouth County. It is used for the face of buildings. The granite itself is of a light-gray color which blends very well with the colors of the seam-face stone, and both varieties are often used in the same building. The stone is used in blocks about 5 to 15 inches thick and generally as decorative ashlar work and rustic masonry. Recent buildings in which it has been used are the Harkness Memorial Quadrangle, Yale University, New Haven, Conn.; Church of the Holy Innocents, Brooklyn, N. Y.; Woodward Avenue Methodist Episcopal Church, Detroit, Mich.; and Sears residence, Brookline, Mass. The only operator in Norfolk County in 1922 was the Bates Bros. Seam Face Granite Co. (address, Quincy). (See Plymouth County.)

Wrentham: R. H. Curry, High Rock quarry; light-gray medium-grained stone; curbing.

Plymouth County. (For description of granite see Weymouth, Norfolk County.)
Hingham:
J. E. L. Miller (address, East Weymouth); seam-face granite; buildings.
Plymouth Quarries (Inc.) (address, Boston); seam-face granite; buildings.
Lakeville: Frank C. Taylor (address, New Bedford); seam-face granite; buildings.
Suffolk County:
West Roxbury: West Roxbury Trap Rock Co.; crushed stone.
Worcester County:
Fitchburg: McCauliff Quarry Co. (Inc.); light blue-gray granite; rough and dressed construction, buildings, paving blocks, curbing, crushed stone.
Holden: Worcester City (address, Worcester); crushed stone, rough construction.
Milford. The granite quarried at Milford is a medium to coarse-grained stone, generally light pinkish gray, with spots of black mica, and is known to the trade as "Milford Pink." It has been used in many large structures in the Eastern and Middle States, notably the Pennsylvania Railroad Terminal, New York City (1906); Cuyahoga County Courthouse, Cleveland (1911); Post Office, New York City (1913); Perry Memorial, Put in Bay, Ohio (1914); Freer Art Gallery, Washington (1917); Exchange National Bank, Pittsburgh, Pa.; Shaw Mausoleum, Worcester, Mass.; base and approaches for Philadelphia Public Library, Philadelphia; Riggs Bank and American Security & Trust Co.'s building, Washington. The producing companies in 1922 were as follows:
Milford Pink-Victoria White Granite Co., East quarry.
Monti & Rossi, Sherman quarry.
Pink Granite Co. of Milford, Bay State quarries.
Uxbridge:
Blanchard Bros. Granite Co. (address, Linwood); light-gray medium-textured granite gneiss; rough construction, dressed building, curbing, rubble, crushed stone.
Carrick & Gough (address, Whitinsville), Blanchard ledge; light-gray gneiss; monuments.
Worcester: Worcester Broken Stone Co., Belmont Hill quarry; crushed stone.

Connecticut.—Connecticut is the smallest producer of granite among the New England States. The chief centers are at Stony Creek, Waterford, and Niantic. The companies active in 1922 were as follows:

Hartford County:
Glastonbury: Glastonbury Granite Works (Inc.) (address, Manchester); fine-grained dark-gray gneissoid granite; rough construction, curbing.
Litchfield County:
Thomaston: Plymouth Granite Co. (Inc.); fine-grained bluish-gray stone; monuments.
New Haven County:
Ansonia: Ansonia Quarry Co.; curbing, construction.
Branford: John F. Meehan (address, New Britain); "Branford Pink"; monuments, trimmings for buildings.
Stony Creek: Milford Pink-Victoria White Granite Co. (address, Milford, Mass.); "Branford Red" and "Stony Creek Red," reddish-gray coarse-grained gneissoid granite; buildings, monuments, mausoleums.
New London County:
East Lyme: Connecticut Pink Quarries (Inc.) (address, Niantic); monuments.
Groton: John Salter & Son; fine-grained greenish-gray granite; monuments.
Millstone: Henry Gardiner; "Millstone," fine-grained dark-gray granite; buildings, monuments, paving blocks, rubble.
Niantic:
A. Malnati & Co.; "Golden Pink," fine-grained pinkish-gray granite; monuments.
William Sieverts, Golden Pink quarry; "Golden Pink"; monuments.

New London County—Continued.
Waterford: Booth Bros. & Hurricane Isle Granite Co. (address, New York City); "Connecticut White," fine-grained light buff-gray stone; rough and dressed monumental, buildings, paving blocks, riprap.
Windham County:
Oneco: R. B. Marriott & Sons; fine dark blue-gray gneissoid granite; buildings, paving blocks, curbing, rubble.

Rhode Island.—"Westerly Pink," "Blue Westerly," and "Red Westerly" have long been familiar terms to monument dealers and buyers of monumental granite. This stone is quarried near Westerly and Bradford, Washington County, R. I. The "Westerly Pink" is a fine, even-grained light-pinkish or buff-gray granite. "Blue Westerly" is a bluish medium-gray stone, with fine black particles and fine, even-grained texture. "Red Westerly" is an even-grained, medium to coarse reddish-gray stone. The "Blue Westerly" and "Westerly Pink" are used for monumental work, and the "Red Westerly" for construction. Granite is also quarried in Bristol, Kent, and Newport counties, but mostly for crushed stone, paving blocks, and rough construction stone.

The following quarries were reported in operation during 1922, although the strike of granite cutters greatly curtailed the output of the plants:

Bristol County:
Bristol: L. H. Callan; crushed stone.
Kent County:
Coventry: R. B. Marriott & Sons (address, Oneco, Conn.), Jackson Wood Ledge quarry; buildings, paving blocks, curbing.
Newport County:
Newport:
Newport City quarry; crushed stone, rough construction.
J. K. Sullivan, Rocky Farm quarry; crushed stone.
John F. Sullivan; crushed stone.
Washington County:
Westerly:
New England Granite Works; monuments, building.
Smalley Pink & Red Westerly Co.; monuments, paving blocks, rubble.
Smith Granite Co.; "Blue-white Westerly," "Cream-white Westerly"; monuments.
Sullivan Granite Co., Crumb, Klondyke, Newall, and Sullivan quarries; monuments.
Westerly Blue Quarry Co.; monuments.

NORTH ATLANTIC STATES.

The most noticeable feature in the granite output of New York, New Jersey, and Pennsylvania is the considerable amount of granite (gneiss) sold for rough construction work in Pennsylvania.

New York.—The output of granite in New York is not large, and there are no well-established granite centers. The operations in 1922 were as follows:

Bronx County:
Bronx: Edw. J. Davey (address, New York City); buildings, monuments.
Clinton County:
Ausable Forks:
Champlain Green Granite Co.; green granite; monuments.
Keystone Green Granite Co. (address, Waterbury, Vt.); light-green granite; interior building, monuments. The stone will be used in the Theodore Thomas Memorial, Chicago,

Essex County. A coarse-grained pink granite, for use in stucco work, concrete facing for blocks, bricks, posts, etc., and for poultry grit, is quarried and crushed at Crown Point and Port Henry by the Crown Point Spar Co., New York City, and M. L. Thomas (Rose Rock quarry), Crown Point.

Herkimer County:

Little Falls: General Crushed Stone Co. (address, Easton, Pa.); crushed granite for concrete, road work, and ballast.

Jefferson County. Granite is quarried at Alexandria Bay and on Wellesley Island to furnish paving blocks for the Wisconsin Granite Co., Chicago, Ill.

New York County. The stone quarry on Blackwells Island from which buildings and sea walls on the island were constructed was idle in 1922.

Orange County. The United States Military Academy, West Point, quarries granite on the grounds of the Academy, and the Cadet Hospital was built of this stone in 1922.

Westchester County. In 1922 granite was quarried by the Bronx Parkway Commission, at the Dunwoodie and Mile Square quarry, near Yonkers, and used for rough construction and rubble work. A yellowish-brown granite is quarried near Peekskill, at the Mohegan granite quarries, by Grenci & Ellis. This quarry furnishes stone at intervals for the construction of the Cathedral of St. John the Divine, New York City. The stone is also used for monumental work and in 1922 was used in the Eugene Field Memorial, Chicago, the Butterfield Memorial, Grand Rapids, Mich., and several other buildings. The Millstone Hill quarries are also near Peekskill and are operated by John Brown & Sons, New York City, for building and monumental work. Stone for the Twenty-seventh Ward Memorial, Pittsburgh, Pa., was furnished from these quarries in 1922. Other small quarries supplying stone for rough construction work are operated in the neighborhood of New Rochelle. Among the operators are John Bombasi, Vincenzo Idoni, Sebastian La Barbiera, and Pitt M. Skipton.

New Jersey.—There were only two granite quarries in operation in New Jersey in 1922—the Pompton Crushed Stone Co.'s quarry, at Bloomingdale, for crushed stone, and the Jesse A. Howland quarry, at Rockaway, Morris County, for stone for sea walls.

Pennsylvania.—Very little true granite is quarried in Pennsylvania, the greater part of the material being gneiss, used for rubble and foundation work, small ashlar stones for faces of buildings, and diabase and gabbro ("black granite") for monuments. A greater quantity of material is sold in Pennsylvania for foundations and facing than in any other State. In and around Philadelphia stone excavated in digging cellars is often used for the foundations of buildings and even for the buildings themselves. The following granite and gneiss quarries were in operation in Pennsylvania in 1922:

Berks County:

Barto: R. Etta Barr (address, Allentown); crushed stone.

Seisholtzville: Walker Granite Co. (address, Alburtis); buildings.

Bucks County:

California: Pennsylvania Black Granite Co. (address, Quakertown); "black granite"; rough and dressed for monuments and mausoleums.

Coopersburg: Samuel Bradford, Rocky Valley quarry; "Bonnie Brook Black Granite"; monuments, paving blocks.

Roedey: French Creek Granite Co. (address, St. Peters); "French Creek Black"; monuments, paving blocks.

Shelly:

William Polambo Granite Co. (address, Quakertown); "Blue and Dark Pearl"; monuments.

Wenz Co. (address, Allentown); "black granite" (diabase); monuments, paving blocks, crushed stone. Stone from this quarry was used in 1922 in the Liberty Trust Co.'s building, Allentown, the Harry L. Ritter monument, Easton, and the Ellen Goetz monument, Nazareth.

Chester County:
Devault: Chester Valley Granite Co.; rough construction, riprap, crushed stone.
Delaware County:
Broomall: Foxcroft Stone Co. (address, Philadelphia); rough construction.
Burmont: James A. Maher; rough construction.
Cardington: E. Burlein; rough construction.
Chester: Baker Construction Co., Leiper and Deshong quarries; rough construction.
Clifton Heights:
Charles A. Evans (address, Drexel Hill); rough construction.
Gillespie & Son (address, Oakview); rough construction.
Drexel Hill: McManus & James, Hillside quarry; rough construction, riprap, crushed stone.
Lima: B. F. Fields; rough construction.
Llanerch: James J. Logue, sr.; rough construction.
Media: E. L. Barrett; rough construction.
Morton: Vincenzo Di Francesco (address, Llanerch); rough construction.
Springfield: Edw. A. Mullen (address, Philadelphia), Johnson quarry; rough construction.
Swarthmore: Callendar I. Leiper; rough construction.
Trainer: D. M. Johnson (address, Chester); rough construction.
Montgomery County:
Bala: P. J. Lawler; rough construction, curbing, rubble, crushed stone.
Oaklane: Joseph Aiello; rough construction.
Philadelphia County:
Germantown: J. W. Fowler; rough construction.
Holmesburg:
City of Philadelphia, Bureau of Charities and Correction quarry; crushed stone.
Holmesburg Granite Co. (address, Philadelphia); rough construction, buildings, curbing, crushed stone.
Philadelphia:
Chestnut Hill Contracting & Gray Stone Quarry Co.; "Chestnut Hill Gray Stone"; rough construction, rubble, stucco.
Thomas P. Lee, Seventy-first Street & Haverford Avenue quarry; rough construction.

The magnitude of the rough construction work done in Pennsylvania may be seen in the following table. The sandstone, quartzite, and mica schist sold for this purpose are reported on page 331.

Granite sold in Pennsylvania for different purposes, 1922.

	Quantity.	Value.
Rough construction (foundations, rough face, etc.)..short tons..	158,460	$291,240
Approximate equivalent in cubic feet	1,900,000	
Building stone (architectural, rough and dressed)..cubic feet..	84,480	56,244
Approximate equivalent in short tons	7,100	
Rubble and riprap..short tons..	9,650	13,908
Monumental stone (rough and dressed)..cubic feet..	26,820	125,924
Approximate equivalent in short tons	2,260	
Paving, curbing, and flagging..short tons..	920	8,073
Crushed stone, stucco, etc..do....	53,060	82,054
Total (quantity approximate, in short tons)	231,450	577,443

It will be seen that 68 per cent of the total granite and gneiss quarried and 96 per cent of the stone sold for building is used for foundations and ashlar.

SOUTHEASTERN ATLANTIC STATES.

North Carolina and Georgia have at present the only important granite centers in the Southeastern Atlantic States. Granite produced at Elberton and Lithonia, Ga., and at Balfour, Mount Airy,

and Salisbury, N. C., is used for buildings, monuments, mausoleums, curbing, and paving blocks and is shipped to various parts of the country. A description of the granite quarries and deposits in these States is given in a bulletin of the Geological Survey,[3] and a list of the operators of quarries in 1922 is given below, by States.

Delaware.—The only granite at present quarried in Delaware is taken out near Wilmington, Newcastle County, and is used entirely for crushed stone. The operating companies are the Arundel Corporation (address, Baltimore, Md.) and Alex. Petrillo, Shell Pot quarry (address, Edgemore).

District of Columbia.—The stone quarried in the District of Columbia is a medium to dark gray gneiss and is sold as rubble, chiefly for foundation work and for residence walls. Some is used for seam-face work. The operators of the quarries in 1922 were Frank Ginechesi, Frank Perna, Louis Perna, C. Spano & Son, and Frank Pittiglio, all of Washington.

A blue-gray granite, "Bethesda Blue," quarried at Bethesda, Montgomery County, Md., near the border of the District of Columbia, by the Bethesda Blue Granite Co., finds its entire market in the District. It is used for monuments and rubble. Gray gneiss quarried in Arlington County, Va., by the Columbia Granite & Dredging Co. also finds its market for rubble, rough construction, and crushed stone in the District.

Maryland.—Granite for other than rough construction, rubble, and crushed stone in Maryland in 1922 was quarried chiefly by the Guilford & Waltersville Granite Co. (address, Baltimore) at Granite, Baltimore County, and was sold rough for building and monumental work, paving blocks, and rubble. This stone is a medium-grained blue-gray granite and has been widely used in Maryland (especially in Baltimore), the District of Columbia, and Pennsylvania as a building material and to a less extent in Delaware, West Virginia, and other States. The Port Deposit Quarry Co., at Port Deposit, Cecil County, which formerly furnished a large amount of building stone, was idle in 1922. A small quarry operated by the Bethesda Blue Granite Co., Bethesda, Montgomery County, produced stone for monumental and rubble work, which was marketed chiefly in Washington. This stone is uniform blue-gray in color and somewhat gneissoid. Other quarries operating in Maryland for rough construction (principally foundation work) and crushed stone were as follows:

Baltimore:
- Falls Road Quarry Co.; rough construction.
- Gwynns Falls Quarry Co.; rough construction, crushed stone.
- United Realty Co., Dickeyville; crushed stone.

Baltimore County:
- Blue Mount: J. E. Baker Co. (address, York, Pa.); crushed stone.
- Pikesville: Mallonee Bros., Hidey quarry; rough construction, crushed stone.
- Mount Washington: McMahon Bros.; rough construction, crushed stone.

Virginia.—The only granite quarry operated in Virginia in 1922 for other than crushed stone and rough construction work was the Albin Netherwood quarry, at Richmond, Henrico County. The stone was used for rough construction work, monuments, and range

[3] Watson, T. L., Granites of the southeastern Atlantic States: U. S. Geol. Survey Bull. 426, 1910.

stone. Operators of other plants, chiefly for crushed stone, were as follows:

Arlington County:
Columbia Granite & Dredging Co. (address, Washington, D. C.); crushed stone, rubble, riprap.
Goochland County:
Boscobel:
H. J. Harris Estate (address, Richmond); crushed stone.
Holland & Beatty; crushed stone.
Henrico County:
Richmond: Sunnyside Granite Co.; crushed stone.
Nelson County:
Buffalo Station: Bodine Stone Co.; crushed stone.
Pittsylvania County:
Danville: City of Danville; crushed stone.

North Carolina.—The most widely known granite quarried in North Carolina is the light-gray, almost white stone obtained at Mount Airy, Surry County, from the quarries of the North Carolina Granite Corporation. This stone is used all over the United States and is sold rough and dressed for buildings, monuments, and mausoleums, for rubble for buildings, paving blocks, curbing, riprap, and crushed stone for concrete and stucco work. In 1922 stone for the coping of the reflecting pool east of the Lincoln Memorial, at Washington, and also for the Victory Monument at Danville, Ill., was furnished from these quarries. The union stonecutters at the different plants of this company went on strike in April, 1922, and the plants were operated under open-shop conditions the remainder of the year. A pink granite ("Balfour Pink") quarried by the Harris Granite Quarries Co. at Balfour, near Salisbury, Rowan County, has found considerable favor for monuments and is sold both as rough and dressed stone. The same company operates other quarries at Salisbury and a quarry at Stacey, Rockingham County, for durax paving blocks and crushed stone. Other granite quarries operated in the State in 1922, with their products are given below:

Alexander County:
Hiddenite: Hiddenite Crushed Stone Co. (address, Concord); crushed stone.
Buncombe County:
Asheville: Asheville Construction Co.; crushed stone.
Caswell County:
Pelham: Collins Granite Co. (address, Danville, Va.); crushed stone.
Davidson County:
Southmont: William Lefler; paving blocks.
Henderson County:
Balfour: Home Ice & Oil Co. (address, Asheville); crushed stone.
Hendersonville:
P. H. Reid, Laurel Park quarry; crushed stone.
Wright & Dixon; rough construction.
Rockingham County:
Reidsville:
Reidsville Granite Co. (address, High Point); crushed stone.
Cheatwood & Dixon (address, Wentworth); crushed stone.
Rowan County:
Faith: Brown & Artz (address, Salisbury); paving blocks, curbing.
Granite Quarry:
Central Contracting Co. (address, Salisbury); dressed building stone, durax paving blocks, curbing.
Salisbury Granite Corporation (address, Salisbury), Tallassee Power Co. and Harris Granite Co. quarries; paving blocks.

Rowan County—Continued.
Salisbury: B. C. Eagle; curbing.
Woodleaf: Hardaway Contracting Co. (address Columbus, Ga.); crushed stone used in own contracting work.
Stanley County:
Albemarle: Hardaway Contracting Co. (address Columbus, Ga.); stone used by company in construction of dam for the city waterworks of Albemarle.
Vance County:
Greystone: Raleigh Granite Co. (address Raleigh); crushed stone.
Wake County:
Raleigh: City of Raleigh; crushed stone.
Rockton Siding: Raleigh Granite Co. (address, Raleigh); crushed stone.
Wake Forest: Raleigh Granite Co. (address, Raleigh), Rolesville quarry; building, paving blocks, durax blocks, curbing, rubble.
Wilson County:
Sims: Neverson Granite Quarry (Inc.); rough building, crushed stone.

South Carolina.—The building and monumental granite quarries in South Carolina are mostly small and of only local importance. The greater part of the stone quarried is crushed. The following companies were reported in operation in 1922:

Edgefield County:
Trenton: Southern Crushed Stone & Granite Co.; crushed stone, rubble.
Fairfield County:
Rion: Winnsboro Granite Corporation; "Winnsboro Blue;" monumental.
Greenville County:
Greenville: Saluda Crushed Stone Co.; crushed stone.
Greenwood County:
Greenwood:
J. B. Benjamin; curbing.
Johnson Dalton; curbing, rubble.
Laurens County:
Cold Point: Byron Nichols Granite Co. (address, Waterloo); curbing, rubble.
Lexington County:
Cayce: Weston & Brooker Co. (address, Columbia); crushed stone.
Pickens County:
Beverly: Beverly Stone & Sand Co., crushed stone.
Richland County:
Columbia: Palmetto Quarries Co.; crushed stone, riprap.
Spartanburg County:
Pacolet: David McBain; rough construction.
Union County:
Lockhart: Hardaway Contracting Co. (address, Columbus, Ga.); crushed stone for company's own construction work.
York County:
Clover: Clover Quarry Co.; crushed stone.

Georgia.—The largest centers of granite production in Georgia are in De Kalb and Elbert counties, where the stone is sold for buildings, monuments, paving blocks, curbing, rubble, and crushed stone. Atlanta is the largest market for paving blocks and other street material, but shipments are made to neighboring States and as far away as Illinois, Maryland, Mississippi, Missouri, Louisiana, Ohio, Tennessee, and West Virginia. The quarry operators in 1922 were as follows:

De Kalb County. The granite at Lithonia is a gray medium to coarse grained gneiss, with its foliation intricately contorted; that from Stone Mountain is lighter gray, of medium to fine grain, without gneissic structure, but with many round to oval segregations of nearly white color.

De Kalb County—Continued.
Lithonia:
Arabia Granite Co. (address, Atlanta); paving blocks, curbing, rubble, crushed stone.
Davidson Granite Co.; paving blocks, curbing, rubble, crushed stone.
J. W. Haygood, Collinsville quarry; curbing, rubble.
Johnson Granite Co.; paving blocks, curbing, rubble, concrete.
Kinney & Newmeyer, Almand quarry; curbing, rubble.
New & Coggins Granite Co., Chupp quarry; curbing, rubble.
Pine Mountain Granite Co. (address, Atlanta); paving blocks, curbing, rubble, crushed stone.
E. W. Regan & Co., Brantley quarry; curbing.
Wilson-Chapman Granite Co.; buildings, paving blocks, curbing, rubble, crushed stone.
Stone Mountain: Stone Mountain Granite Corporation; buildings, monuments, mausoleums, paving blocks, rubble.
Elbert County. Most of the granite quarried in Elbert County is a fine even-grained dark and light blue-gray granite. Stone was also quarried and crushed for road work in this county at Oglesby by the State of Georgia.
Elberton:
American Granite Co.; rough monuments.
Elbert Granite & Marble Works; buildings, curbing, monuments.
Georgia Granite Corporation; "Elberton Blue"; rough and dressed monuments, mausoleums.
Granite Construction Co.; rough monuments.
Mercer Granite Co.; rough monuments.
Oglesby Granite Co.; "Oglesby Dark Blue," "Oglesby Light Blue"; rough monuments.
Fulton County:
Atlanta: Georgia Railway & Power Co., City Gate quarry; medium-grained blue and gray; crushed stone for road work, railroad ballast, and stone dust.
Hancock County:
Sparta:
Georgia-Quincy Granite Co.; coarse-grained gray; curbing, crushed stone, riprap, monuments.
W. T. Macon Granite Works; coarse-grained gray; curbing, crushed stone, riprap, monuments.
Stephens County:
Toccoa: Toccoa Rock Crushing Co.; crushed stone.

CENTRAL STATES.

The granites quarried in the Central States are nearly all dark, red and red-brown being the predominating colors, with few of the light granites characteristic of New England. The greater part of the stone is sold for monuments, and smaller amounts for paving blocks, buildings, curbing, riprap, rubble, and crushed stone. Minnesota and Wisconsin are the largest producers.

Wisconsin.—The granites produced in Wisconsin are dark red, reddish brown, dark gray, dark green, and black and are used principally for monumental stone but also for paving blocks, crushed stone, rubble, stucco, curbing and flagging, and rough construction work. There were some labor strikes in this State in 1922, especially among the paving-block cutters, and production was curtailed on this account and on account of shortage of labor and cars for transportation. The following firms reported operations in 1922:

Ashland County:
Mellen: Effenberger Bros.; "black" gabbro; monuments.
Green Lake County:
Berlin and Utley: Wisconsin Granite Co. (address, Chicago); grayish-black rhyolite with pink feldspar crystals, "Berlin Rhyolite"; paving blocks, crushed stone, stucco, rough construction, monuments.

Marathon County. The granite quarried at Granite Heights and Wausau ranges in color from gray with a pinkish cast through reddish brown to brilliant red. It is an even-grained medium-lustered stone, and the red color is due to red and flesh-colored feldspar. A grayish-green granite of about the same texture is also quarried at Wausau.

Granite Heights:

American Granite Co. (address, Milwaukee); "Wisconsin Mahogany," "Red Wausau"; monuments.

Anderson Bros. & Johnson Co. (address, Wausau); "Wisconsin Ruby Red"; monuments.

Wausau:

Lake Wausau Granite Co.; monuments.

Marathon Granite Co.; "Red Wausau," "Parcher Green"; monuments.

Trappe River Granite Co.; monuments; new quarry opened in 1922.

Marinette County:

Amberg:

Hollander Bros.; monuments.

Peter McTrusty; monuments.

Mattison Bros.; monuments.

Wisconsin Granite Co. (address, Chicago); paving blocks.

Marinette: Pike River Granite Co., Pike River and Middle Inlet quarries; "Pike River Gray" (medium fine grained granite), "Montrose Red," "Marinette Red" (dense fine-grained reddish-brown granite); monuments.

Marquette County:

Montello: Montello Granite Co.; dense fine-grained red granite, "Montello Granite"; monuments, paving blocks, crushed stone.

Waupaca County:

Big Falls: Big Falls Granite Co.; paving blocks, monuments.

Waushara County:

Lohrville:

Badger Crushed Granite Co. (address, Chicago), Spring Lake quarry; crushed stone.

Universal Granite Quarries Co. (address, Chicago); paving blocks, crushed stone, rubble, monumental.

Waushara Granite Quarries Co. (address, Chicago); paving blocks, rough construction, rough monumental, crushed stone.

Red Granite: Wisconsin Granite Co. (address, Chicago); paving blocks, crushed stone, stucco, rough monumental, rough construction, durax blocks, curbing, granite dust.

Minnesota.—Minnesota has become one of the principal States in the production of granite for monuments, with the St. Cloud district as the center of the quarrying and manufacturing activities. In 1922 the State ranked second in quantity of granite sold for monuments, being exceeded only by Vermont. As most of the quarrymen of this State operate manufacturing plants and sell their stone as dressed or cut stone, the value of the monumental stone sold by the quarrymen of Minnesota was slightly larger than that of Vermont, where most of the monumental stone quarried is sold rough. There were few strikes in Minnesota in 1922, and this settled condition of labor is reflected in an increase of nearly 120 per cent over the quantity of monumental stone sold in 1921, though the quantity was 24 per cent less than in 1920. All the plants operate on the open-shop plan.

The operators in Minnesota in 1922 were as follows:

Benton County:

Watab: State Crushed Granite Co.; crushed stone.

Lac Qui Parle County:

Odessa: Ortonville Monument Works (address, Ortonville); "Ruby Red"; dressed monuments.

Millelacs County:

Isle: Hilder Granite Co. (address, St. Cloud); monuments. (See also Sherbourne County.)

Morrison County:
Glenola: Melrose Granite Co. (address, St. Cloud); monuments.
Little Falls: Little Falls Black Granite Co.; diorite, "Little Falls Black"; dressed monuments.
Redwood County:
North Redwood: Thomas Hosken; pale-pink and greenish-gray gneiss; monuments.
Renville County:
Morton: Anderson Granite Co.; gneiss; dressed monuments.
St. Louis County:
Virginia: Virginia Crushed Stone Co.; crushed stone.
Sherbourne County:
East St. Cloud: Hilder Granite Co. (address, St. Cloud); fine-grained gray granite; monuments, rubble, crushed stone. This company also operates in Millelacs County, and the trade names of the different granites from its quarries are "Minnesota White," "Hilder Gray," "Sunset Red," and "Green Pearl."
St. Cloud: Minnesota State Reformatory; medium-grained gray granite; crushed stone.
Stearns County. The granite of the St. Cloud district is either red or gray and is known as "St. Cloud Red," "St. Cloud Gray," and "Rockville," but many of the quarries have their own names for their product. The red granite is of medium to coarse grain, the gray granite is somewhat finer, and the "Rockville" granite is a pinkish-gray stone that is much coarser than the others. Full descriptions of most of the quarries are given in Bulletin 663.[4]
Rockville:
John Clark; pinkish-gray coarse-grained granite, "Minnesota Pink"; buildings, monuments. In 1922 used in construction of America Fore Building and Belden Hotel, Chicago, Ill.; Adkar Temple Building, Tulsa, Okla.; Chancery Building, St. Paul, Minn.; Governor Yates monument, Springfield, Ill.
Rockville Granite Co. (address, Cold Spring); pinkish-gray coarse-grained stone, "Minnesota Pearl Pink," "Minnesota Pink"; dressed building and dressed monumental work. This stone was used in 1922 for the court house, St. Cloud, a building with granite columns 66 feet long by 4 feet 6 inches in diameter, all polished. It was also used in carved work for the D. A. R. Memorial at St. Paul, and shipments were made to Minneapolis and Fergus Falls, Minn.; Huron, S. Dak.; Vinton, Iowa; Benton Harbor and Detroit, Mich.; and Galesburg and Springfield, Ill.
St. Cloud:
Empire Quarrying Co.; medium-grained red granite, "Rose Red St. Cloud"; monuments.
General Granite Co. (address, Sauk Rapids); "St. Cloud Gray"; rough for monuments.
Great Northern Granite Co.; fine-grained red and gray, "Indian Red St. Cloud," "Victory Red St. Cloud," "Victory Gray St. Cloud"; rough and dressed for monuments,
Robert Graham; even-grained gray; rough for monuments and paving blocks.
Granite City Granite Co.; medium to coarse grained red, also a gray granite quarry, "St. Cloud Superior Red," "St. Cloud Superior Gray"; dressed for monuments.
Holes Bros.; medium-grained red, "Red Rock"; dressed for monuments.
Independent Granite Co.; rough for monuments.
Lintgen Granite Co.; rough for monuments.
Melrose Granite Co.; red and gray, "Melrose Red," "Melrose Gray"; dressed for monuments, paving blocks.
National Granite Works; even-grained red, "Minnesota Mahogany"; rough for monuments.
Peerless Quarry Co.; rough for monuments.
Pioneer Granite Co.; coarse and fine grained red, "Pioneer Gray," "Minnesota Pink," "Black Diamond Red"; monuments.
Royal Granite Co.; "Royal Gray"; dressed for monuments.

[4] Bowles, Oliver, The structural and ornamental stones of Minnesota: U. S. Geol. Survey Bull. 663, 1918.

Stearns County—Continued.
St. Cloud—Continued.
St. Cloud Granite Works; medium-grained red and gray, "Red Pearl," "Dark Gray"; dressed for monuments.
A. M. Simmers & Sons; rough and dressed for monuments.
Southwestern Granite Co.; rough for monuments.
Streitz Bros.; gray; rough for monuments.
Waite Park:
Benson & Solfelt; rough for monuments.
Campbell North Star Granite Co. (address, St. Cloud); "North Star Red"; dressed for monuments.
Charles Johnson; rough for monuments.

Missouri.—Granite used for monuments, construction work, paving blocks, and other purposes is quarried in Missouri. The stone sold for monuments is mostly red and has been shipped in the form of small memorials all over the United States as "Missouri Red" granite. The quarries in active operation in 1922 were as follows:

Iron County:
Graniteville:
Schneider Granite Co.; monuments.
A. J. Sheahan Granite Co.; dark-red syenite; monuments, paving blocks, riprap, crushed stone.
Pilot Knob:
William Milne; monuments.
Pilot Knob Ore Co. (address, St. Louis); crushed stone.
St. Francois County:
Knob Lick: A. G. Asplof; paving blocks.
Wayne County:
Kerrigan: P. O'Keefe, Granite Bend quarry; riprap.

South Dakota.—Granite for monumental stone was reported as quarried in South Dakota in 1922 at Milbank, Grant County, by the Milbank Mahogany Granite Co. (address, Ortonville, Minn.), and at Big Stone Gap by the Keystone Granite Co. The Paving Granite Co., Rapid City, operated a quarry for riprap and crushed stone. The monumental stone is known as "Hunters Mahogany" or "South Dakota Mahogany."

Arkansas.—Small quantities of light-gray to yellowish-gray syenite (pulaskite) are quarried annually near Little Rock, Pulaski County, Ark., for local use as foundation stone, rubble, rough construction, and monuments. The operators are Samuel Stewart and Hilliard Bros., both operating on the land of the Braddock Land & Granite Co., and W. P. Funston. In 1922 the Little Rock Granite Co. furnished rubble and crushed stone from surface stone.

Oklahoma.—The granite quarried in Oklahoma is used to supply local demand for building and monumental stone and some crushed stone. In Comanche County John M. Hazel operated a quarry for monumental stone at Cache. In Greer County quarries were operated at Granite by Pellow Bros. for building and monumental work, and by the Oklahoma State Reformatory for crushed stone. In Kiowa County Py McVeigh operated the Blue Mountain quarry at Cold Springs for building and monumental stone; P. E. Johnson Granite Co. operated a quarry at Snyder and a quarry and finishing plant at Cold Springs; and Parsons Bros. operated a quarry at Mountain Park for monumental stone. The total output of the State is not large.

Texas.—The granite production of Texas is at present confined to Burnet, Gillespie, Llano, and Mason counties. The largest center is at Llano, Llano County, where the stone is in general a light to dark gray fine to medium grained granite. Most of the stone is consumed

within the State. The Granite Mountain Quarry, at Marble Falls, operated by the Texas & New York Granite Co. (address, New York City), which has been idle for several years, has been reopened, and in 1923 the product will be shipped to New York City for the eastern addition to the Museum of Natural History. The following are the names of active companies in 1922:

Burnet County:
Marble Falls: Darragh Bros.; red granite; buildings, monuments, riprap.
Gillespie County:
Fredericksburg: Nagel Bros.; red granite; monuments.
Llano County:
Llano:
Blue Diamond Granite Co.; monuments, curbing.
Cassaday Gray Granite Co.; monuments.
Grady Faubion; monuments.
T. W. Norton; monuments.
Texas Granite Co.; monuments.
Mason County:
Pontotoc: Blodgett Granite Works (address, Llano); buildings, monuments.

ROCKY MOUNTAIN STATES.

The principal granite district of the Rocky Mountain States is at Salida, Chaffee County, Colo., and the product is sold for monumental stone.

Idaho.—Granite for monuments was quarried at Kamiah, Lewis County, Idaho, in 1920, by the Kamiah Granite Works, but the quarry has been idle for two years.

Montana.—Granite was quarried in Montana in 1922 by the following firms:

Chouteau County:
Square Butte: Rudin Bros. Granite Co., Lone Tree quarry; dressed building (State Biology Building, Bozeman) and dressed monumental.
Jefferson County:
Grace: Butte Tombstone Co. (address, Butte), Grace and Butte quarries; monuments (Grace) and curbing (Butte).
Lewis and Clark County:
Clancy: Kain Granite Co. (address, Helena); monuments and dressed building (State University building, Missoula, and State College, Bozeman).
Park County:
Gardiner: Livingston Granite & Marble Works (address, Livingston); monuments (American Legion monument, Butte), pebble dash for stucco, and chicken grit.
Silverbow County:
Feeley: Butte Tombstone Co. (address, Butte); monuments.

Utah.—The only granite quarried in Utah in 1922 was taken from the Cottonwood quarry, in Little Cottonwood Canyon east of Sandy, Salt Lake County, by the Utah Granite & Marble Co. for rough building and monumental work.

Colorado.—A fine-grained dark blue-gray quartz diorite is quarried at Salida, Chaffee County, and known as "Salida Blue" and "Salida Dark Gray." At present it forms the greater part of the granite production of the State. This stone is used entirely for monuments and is sold by the producers both as rough and dressed stone. The active quarries at this location in 1922 were those of the Black Diamond Granite Co., Colorado Wholesale Granite Co (Bon Accord quarry), Nan T. McLaughlin, and Salida Granite Corporation (Dark Salida quarry). The production of this district for both rough and dressed stone from 1916 to 1922 has been as follows:

Granite produced at Salida, Colo., 1916–1922.

Year.	Cubic feet.	Value.	Year.	Cubic feet.	Value.
1916	29,830	$50,086	1920	23,750	$172,053
1917	32,910	94,822	1921	14,150	115,509
1918	16,830	86,525	1922	17,190	114,053
1919	18,270	119,710			

A small amount of granite was quarried in 1922 for monuments at Lyons, Boulder County, from the St. Vrain granite quarry by E. G. Bird, of Denver. At Cotopaxi, Fremont County, a medium-grained gray granite is quaried by Peter Noon. In 1920 and 1921 stone from this quarry was used in the construction of the State Office Building, Denver, but its ordinary use is for monuments. At Texas Creek, Fremont County, a light-gray stone for monuments is quarried by J. A. Lamb and the Salida Granite Corporation of Salida, which recently opened the Salida Rose Pink quarry here. Other quarries that have been important in the granite industry of Colorado but were inactive in 1922 are as follows:

Denver Marble & Granite Co. (address, Denver), Silver Plume, Clear Creek County; medium-grained gray granite for monuments and construction.

South Platte Granite Co. (address, Denver), South Platte, Douglas County; medium to coarse grained pinkish granite.

T. F. Callahan (address, Grand Junction), Pearl Gray quarry, near Glenwood Springs, Garfield County.

Edward Seerie Co. (address, Denver), Argyle quarry, Peterhead, Jefferson County; buildings.

Arizona.—The granite output of Arizona is small and is confined to supplying local demands for monuments and buildings. In 1922 all the stone reported sold was used for monuments and came from quarries operated by M. W. Jones & Co. (address, Tucson) at Tombstone, Cochise County, and Vail, Pima County, and by the Arizona Granite & Tufa Co. (address, Phoenix), from the Parr quarry at Prescott. Quarries at Yuma and Mesa, Yuma County, are operated by the United States Bureau of Reclamation for riprap and crushed stone.

PACIFIC COAST STATES.

California.—California is the leading State in the production of granite along the Pacific coast, and the product of the quarries is used for a great variety of purposes. Including the large amount of crushed stone which was reported as granite but which was probably in considerable part light volcanic rock, produced in Los Angeles County, California ranked both in quantity and in value as the largest producer of granite in the United States.

Practically all the granite quarried in California for buildings and monuments has been used within the State, although shipments have been made to Oregon, Washington, and other Western States and to the East. The total quantity of granite sold in 1922 was greater than in 1921, although a strike of union granite cutters began in September, 1921, and lasted well into 1923. Most of the large companies operated their plants on the American or open-shop plan. In 1922 granite was reported as quarried in California at the following localities:

Fresno County. A dark-gray medium-grained monzonite quarried near Academy by the Academy Granite Co. and the Doyle & Ghilotti Co. (address, Clovis) is used almost entirely for monuments, but a small quantity is sold for curbing. The stone is sold both dressed and rough.

Imperial County. Granite is quarried in Imperial County at Andrade (Hanlon quarry) by the Imperial Irrigation Co. and the Inter-California Railway Co. for the purpose of maintaining levees and other structures affected by the floods of Colorado River. In 1922 most of this stone was shipped into Mexico. The United States Bureau of Reclamation quarries granite for its own use at the Potholes quarry, Winterhaven.

Inyo County. Granite for use in road contracts was quarried by A. J. Grier (address, Oakland) at Bishop.

Madera County. The largest granite-producing center in California is in Madera County, where quarries have long been operated at Raymond (Knowles) by the McGilvray-Raymond Granite Co. and the Raymond Granite Co., both of San Francisco. This stone is a medium-grained light-gray granite specked with brilliant black mica crystals and has been widely used in San Francisco for private residences, hotels, banks, and State and Federal buildings. This stone is also used for monumental and mausoleum work, for curbing, and for riprap. It has been used throughout the State and shipped to other Western States, notably Oregon and Washington, and a comparatively small amount has been shipped to New York and other Eastern States. Among the recent buildings erected in San Francisco in which this stone has been used are the City Hall (1914–1916), Public Library (1917), American Bank (1918), State Building, Civic Center (1921–22), California Commercial Union building (1921), Federal Reserve Bank (1922), Anglo-London & Paris National Bank (1922), and Standard Oil building (1922). In Los Angeles stone from Raymond was used in the Bank of Italy in 1922. Among the memorials recently constructed of this granite are the Woodward fountain, Fresno (1920); Glendale Community vault, Los Angeles (1919); Jones memorial, Oroville (1922); Craig memorial, Mountain View Cemetery, Oakland (1922); and Bullard Mausoleum, Sacramento (1922). Both producers operate cutting plants and sell both the rough and finished product.

Nevada County. Ludwig Netz, Nevada City, operates for local monumental work only.

Placer County. The granite produced in Placer County is a light-gray fine to medium grained stone and is used for buildings and monuments, with small amounts sold for riprap and rubble. Most of the stone sold in this district in 1922 had been quarried in 1921, as the quarries and cutting plants were partly closed by a strike of quarrymen and cutters. Stone from Rocklin was used in the construction of the Bank of Italy, San Francisco, in 1920. The operators in 1922 were the Alexon Granite Co., Oscar Anderson, California Granite Co., and Union Granite Co., all in Rocklin.

Plumas County. A small amount of medium-grained dark-gray and "Light Pearl" gray granite is produced annually near Chilcoot by the Sierra Madre Granite Works. The stone is sold rough for manufacture into monuments. "Black granite" is also stated to exist in deposits at this place.

Riverside County:

Corona:

John W. Walker; rough for monuments, buildings.

Blue Diamond Materials Co. (address, Los Angeles) rhyolite porphyry; crushed stone.

Perris:

Bly Stone Co. (address, Los Angeles), Whitehill quarry; dressed building stone, monuments, and mausoleums. This quarry has been recently opened, and in 1922 the stone was used in the construction of the Southern California Telephone Building, Los Angeles, and the First National Bank, Long Beach.

Jean Laborde; buildings, monuments.

Riverside County—Continued.
Perris—Continued.
John Stoupe; "black granite"; crushed for use in concrete, stucco plaster, veneering, floors, etc.
Riverside:
Bly Bros.-McGilliard Stone Co. (address, Los Angeles), Bly quarry; light-gray granite; riprap. Stone from this quarry has also been used for building.
Wineville: Bly Stone Co. (address, Los Angeles), Occidental quarry; monuments.
Sacramento County. The State operates a quarry with prison labor at Folsom, mostly to supply the stone used in the construction of prison buildings. In 1922 stone was cut for use in the construction of the new dining-room building of the prison, and one piece was shipped to San Rafael for the base of the American Legion memorial.
San Benito County. The Logan quarry, at Aromas, is operated by the Granite Rock Co. (address, Watsonville), for crushed stone for concrete, road metal, and railroad ballast.
San Bernardino County. The Declez quarry, at Bloomington, owned by the Southern Pacific Co., operated in 1922 by the Russell-Foell Co. (address Los Angeles) to supply riprap stone.
San Diego County. All the granite quarried in San Diego County in 1922 was sold for monuments. The stone was sold both rough and dressed.
El Cajon: American Marble & Granite Works (address, Los Angeles), Santee quarry.
Escondido: Bly Stone Co. (address, Los Angeles).
Lakeside:
McGilvray-Raymond Granite Co. (address, San Francisco); "Silver Gray," light-gray fine-grained granite.
Southern California Granite Co. (address, San Diego); "Silver Gray."
Santee: Simpson-Pirnie Granite Co. (address, San Diego); medium-grained blue-gray stone.
Temecula (near): Robert J. Magee (address, Pala), Magee quarry; dark-blue granite.
Tulare County. The only granite quarry reported in operation in Tulare County in 1922 was that of the California Granite Co. (address, Rocklin) at Porterville. This stone was sold chiefly for monuments, with small quantities for buildings and for riprap, and is a fine-textured dark-blue granite.

Oregon.—Very little granite is quarried in Oregon. The Northwestern Granite Co., of Haines, Baker County, closed its quarries in November, 1922, for an indefinite period. In Jackson County the Blair Granite Co., of Ashland, has a quarry that furnishes stone for monumental work, and it is also reported that the Ashland Granite Works will operate a quarry near Ashland.

Washington.—The Western Granite Co., at Index, Snohomish County, Wash., quarried granite in 1922 for the Legislative Building at Olympia. Some monumental stone and stone for riprap were also furnished during the year. At Halford, in the same county, the Great Northern Railway Co. annually quarries stone for riprap. In Spokane County granite was quarried at Medical Lake by J. W. Morris and the Washington Monumental & Cut Stone Co., of Spokane (Silver Lake quarry), and near Spokane by the Empire Granite Products Co., of Spokane. Nearly all of this stone was used for monuments. A small portion was used for buildings, rubble, chicken grit, etc.

BASALT AND RELATED ROCKS (TRAP ROCK).

There was an increase of 18 per cent in the quantity of basalt and related rocks sold in 1922. Sales for all the uses to which this stone is applied showed an increase, and the principal product, crushed

stone, increased 16 per cent. The considerable increase in building stone was in the quantity of stone used for foundations and rough face stone. Under "Other uses" as shown in the table of production given below is included 74,080 tons of roofing granules, valued at $515,266, made from altered diabase (greenstone) by the Olivine Co., of Marquette, Mich.; the Advance Industrial Supply Co., of Chicago (plants at Pine Hill, Mich., and Charmian, Pa.); the Emeralite Surfacing Products Co., of Ely, Minn.; and the Blue Mountain Stone Co., of Hagerstown, Md. (plant at Charmian, Pa.). More complete information about roofing granules is given on pages 340–341. Under "Other uses" are also included 144,240 paving blocks, valued at $7,065, produced in Hawaii and New Jersey.

It has been recommended [5] that artificial pebbles of basaltic rocks (trap rock) be tried in tube mills, as they possess superior toughness and lack the brittleness of flint pebbles; but they are inferior to flint in hardness, and although they may prove satisfactory for grinding raw materials for cement, it is unlikely that they will be found hard enough to grind siliceous ores to the required fineness.

Basalt and related rocks (trap rock) sold in the United States, 1921 and 1922, by uses.

Use.	1921		1922	
	Quantity.	Value.	Quantity	Value.
Building stone.....cubic feet..	346,400	$24,679	603,070	$71,685
Approximate equivalent in short tons.....	31,180	.....	54,680	.....
Paving blocks.....number..	55,000	3,650	144,240	7,065
Approximate equivalent in short tons.....	590	.....	1,600	.....
Rubble.....short tons..	37,240	39,851	59,600	119,793
Riprap.....do....	114,120	138,231	237,810	228,448
Crushed stone.....do....	8,285,680	10,913,073	9,603,850	11,654,268
Other.....do....	55,670	331,415	75,360	519,352
Total (quantities approximate, in short tons).....	8,524,480	11,450,899	10,032,900	12,600,611

Basalt and related rocks (trap rock) sold in the United States, 1921–22, by States.

[Quantities approximate.]

State.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
California	1,541,380	$1,414,582	2,134,200	$2,127,230
Colorado	1,720	4,276	.....	.....
Connecticut	1,227,340	1,296,166	1,396,660	1,351,423
Hawaii	201,430	403,946	257,040	500,892
Idaho	186,760	341,608	126,120	160,400
Maryland	352,150	525,071	341,270	520,778
Massachusetts	726,210	898,658	828,540	928,731
Michigan	46,450	173,620	94,560	376,788
Minnesota	(a)	(a)	214,920	334,821
Montana	1,110	2,650	.....	.....
New Jersey	1,342,040	2,194,729	1,581,740	2,412,109
New Mexico	.....	.....	171,000	103,585
New York	112,640	201,677	101,510	151,977
Oregon	749,970	1,040,107	657,050	866,988
Pennsylvania	1,117,940	1,738,890	1,394,770	1,899,287
Texas	(a)	(a)	(a)	(a)
Virginia	(a)	(a)	(a)	(a)
Washington	506,510	637,947	534,310	607,930
Wisconsin	(a)	(a)	90,000	112,500
Undistributed	410,830	576,672	109,210	145,172
	8,524,480	11,450,899	10,032,900	12,600,611

[a] Included under "Undistributed."

[5] Min. and Sci. Press ,Mar. 25, 1922.

Basalt and related rocks (trap rock) sold in the United States in 1922, by States and uses.

State.	Number of active plants.	Building, rough construction.		Rubble and riprap.		Crushed stone, for concrete and road metal.	
		Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
California	30			19,550	$19,882	2,039,230	$2,032,765
Connecticut	20	(a)	(a)	(a)	(a)	1,320,290	1,303,503
Hawaii	7	(a)	(a)	(a)	(a)	209,630	389,351
Idaho	5					126,120	160,400
Maryland	8	18,220	$43,315			229,890	371,283
Massachusetts	18	1,440	2,219			749,300	865,433
Michigan	8					57,730	102,884
Minnesota	4	(a)	(a)			177,290	254,948
New Jersey	37	(a)	(a)	(a)	(a)	1,386,780	2,175,436
New Mexico	1						
New York	2					60,970	100,747
Oregon	50			75,900	74,963	546,850	755,438
Pennsylvania	28	7,950	12,727			855,640	1,078,787
Texas	1					(a)	(a)
Virginia	1					(a)	(a)
Washington	20			137,660	136,819	391,020	464,361
Wisconsin	1					90,000	112,500
Undistributed		27,070	13,424	64,300	116,577	72,930	116,152
	241	54,680	71,685	297,410	348,241	8,313,670	10,284,048
Average value			1.31		1.17		1.24

State.	Number of active plants.	Crushed stone, for railroad ballast.		Other.		Total.	
		Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
California	30	75,400	$74,483	(a)	(a)	2,134,200	$2,127,230
Connecticut	20	(a)	(a)			1,396,660	1,351,423
Hawaii	7	(a)	(a)	1,600	$8,650	257,040	500,892
Idaho	5					126,120	160,400
Maryland	8	(a)	(a)			341,270	520,778
Massachusetts	18	77,800	61,019			828,540	928,731
Michigan	8			(a)	(a)	94,560	376,788
Minnesota	4	(a)	(a)	(a)	(a)	214,920	334,821
New Jersey	37	187,930	227,246	(a)	(a)	1,581,740	2,412,109
New Mexico	1	171,000	103,585			171,000	103,585
New York	2	40,540	51,230			101,510	151,977
Oregon	50	34,300	36,587			657,050	866,988
Pennsylvania	28	500,550	607,529	30,630	200,244	1,394,770	1,899,287
Texas	1	(a)	(a)			(a)	(a)
Virginia	1					(a)	(a)
Washington	20	5,630	6,750			534,310	607,930
Wisconsin	1					90,000	112,500
Undistributed		197,030	201,791	44,730	317,523	109,210	145,172
	241	1,290,180	1,370,220	[b] 76,960	[b] 526,417	10,032,900	12,600,611
Average value			1.06		6.84		1.26

[a] Included under "Undistributed."

[b] Includes 74,080 short tons of roofing granules, valued at $515,266, from Michigan, Minnesota, and Pennsylvania; also 144,240 paving blocks, valued at $7,065 ($48.98 per M), from Hawaii and New Jersey.

MARBLE.

GENERAL CONDITIONS.

The most conspicuous feature of the marble industry in 1922 was the increase of 105 per cent in marble sold for exterior building stone. The item in this class showing the largest increase—177 per cent—was the stone reported as sold dressed or sawed. Marble for interior building work increased 13 per cent. The total increase in marble for building stone was 33 per cent. The average value remained the same as for 1922.

Marble for monumental stone increased 9 per cent, and the average value was the same as for building stone. The conditions of the marble industry in 1922 were satisfactory. Demand was good. Prices were lower most of the time, although there was an upward tendency toward the end of the year. There were no strikes of any importance. Wages were lower than in 1921 but were raised toward the end of the year.

The figures in the following tables include, besides marble, the serpentine (verde antique) sold for interior and exterior building, dimension stone, and by-products. (See pp. 308–309.)

Marble sold in the United States in 1921 and 1922, by uses.

Use.	1921			1922		
	Quantity.	Value.		Quantity.	Value.	
		Total.	Average.		Total.	Average.
Building stone:						
Rough—						
Exterior.....cubic feet..	147,420	$221,888	$1.51	174,550	$393,687	$2.26
Interior.....do....	697,870	1,464,908	2.10	632,870	1,487,174	2.35
Dressed—						
Exterior.....do....	176,253	877,988	4.98	488,950	1,728,206	3.53
Interior.....do....	450,679	2,631,323	5.84	667,390	3,313,316	4.96
Total exterior.....do....	323,673	1,099,876	3.40	663,500	2,121,893	3.20
Total interior.....do....	1,148,549	4,096,231	3.57	1,300,260	4,800,490	3.69
Total building stone.....do....	[a]1,472,222	[a]5,196,107	3.53	[a]1,963,760	[a]6,922,383	3.53
Monumental stone:						
Rough.....do....	114,154	154,836	1.36	341,740	749,738	2.19
Dressed.....do....	701,124	2,944,993	4.20	547,440	2,388,040	4.36
Total monumental stone.do....	[a]815,278	[a]3,099,829	3.80	[a]889,180	[a]3,137,778	3.53
Total building and monumental { cubic feet.....	2,287,500	8,295,936	3.63	2,852,940	10,060,161	3.53
{ approximate short tons..	193,770	.....	.....	242,670	.....	.....
Marble for other uses (by-products) .....short tons..	121,630	284,480	2.34	185,200	474,510	2.56
Total marble sold (approximate) .....short tons..	315,400	8,580,416	.....	427,870	10,534,671	.....

[a] Building stone figures may be somewhat less than given and monumental stone somewhat more, as some of the Tennessee producers were unable to divide their product according to use.

Marble sold in the United States, 1921 and 1922, by States.

[Quantities approximate.]

State.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
Alabama	35,040	$530,711	[a] 25,850	[a] $591,971
Alaska	[b]	[b]	[a] 5,140	[a] 169,635
Arkansas	[c] 2,460	[c] 57,608	[a]	[a]
California	4,060	108,024	27,130	186,352
Colorado			[a]	[a]
Georgia	30,160	1,545,158	61,350	1,867,228
Maryland	10,300	39,295	[a] 21,680	[a] 178,169
Massachusetts	12,400	265,230	12,830	274,769
Michigan	[b]	[b]		
Missouri	23,700	627,729	37,250	816,098
New Jersey			[a]	[a]
New Mexico	[c]	[c]	[a]	[a]
New York	32,090	255,530	52,870	336,956
North Carolina	[b]	[b]	[a]	[a]
Tennessee	65,420	1,599,856	66,680	2,520,517
Texas	[c]	[c]	[a]	[a]
Utah	[b]	[b]	[a]	[a]
Vermont	95,000	3,390,430	117,090	3,592,976
Virginia			[a]	[a]
Undistributed	4,770	160,845		
	315,400	8,580,416	427,870	10,534,671

[a] Alabama includes Arkansas, New Mexico, and Texas; Alaska includes Colorado and Utah; Maryland includes New Jersey, North Carolina, and Virginia.
[b] Included under "Undistributed."
[c] Arkansas includes New Mexico and Texas.

PRODUCING LOCALITIES.

The table of production by States is unsatisfactory, because in many of the States there are so few producers that the totals may not be published, but the following brief notes will reflect the condition of the marble industry in the different States in 1922. Development work on marble deposits in Montana, Nevada, Oregon, and Washington and at certain localities in the producing States was also reported.

Alabama.—The marble sold in Alabama was the output of two companies in Talladega County—the Alabama Marble Co., at Gantts Quarry, and the Moretti-Harrah Marble Co., at Sylacauga. The greater part of the stone was sold for interior building work, and a small part for monuments. Part of the waste material was sold for terrazzo, mosaics, riprap, and furnace flux. Trade names for some of this stone are "Madre Cream," "Madre Veined," and "Alabama Marble." In 1922 stone for use in the interior of the Federal Reserve Bank, Atlanta, Ga., and the Cleveland Discount building, Cleveland, Ohio, was furnished by the Alabama Marble Co. The quarry of the Madras Marble Co., at Sylacauga, was closed down nearly all the year, and the company reported no sales. A mill for sawing marble is being erected, and the company expects to resume operations.

Alaska.—The Vermont Marble Co., of Proctor, Vt., was the only operator of marble quarries in Alaska in 1922. The property is near Tokeen, and the stone was used chiefly for interior work. Trade names for this stone are "Tokeen" and "Gravina."

Arkansas.—The Pfeiffer quarries, at Batesville, Independence County, Ark., operated by the Pfeiffer Stone Co., of St. Joseph, Mo., were the only marble quarries operated in Arkansas. The stone is a crystallized oolitic limestone and is used for exterior building work, and a small quantity is sold for riprap. It is known generally as "Batesville stone." The Independence County Marble Co., of Batesville, opened a marble quarry during 1922; and at Cartney, Baxter County, the White River Marble & Building Stone Co. has been developing for several years a quarry of red fossiliferous marble known as "Red Ark Fossil," but there has thus far been only a small intermittent production.

California.—Marble was produced in five localities in California during 1922—at Keeler, Inyo County, by the Inyo Marble Co., for exterior building, terrazzo, flux, and crushed stone; at Warner Springs, San Diego County, by the Veruga Marble Co., for interior work and roofing granules; at Columbia, Tuolumne County, by the Columbia Marble Co., which furnished specially matched slabs for interior work in the Standard Oil building, San Francisco, and by the Bell Marble Quarries, for interior and exterior building work; and near Sonora, Tuolumne County, by the Tuolumne National Marble Co., for terrazzo work. "Travertine" or onyx marble was quarried and used for interior work at Cement, Solano County, by P. Grassi & Co., of San Francisco. This stone was used for interior work in the State of California building and the Hebrew building, San Francisco, and the Masonic building, Decoto, Alameda County. A small amount of travertine was also quarried at Suisun, Solano County, by S. Mileton, of San Francisco, and used for decorative seats, mantels, etc., and terrazzo.

Colorado.—There were four marble quarries active at Marble, Gunnison County, Colo., in 1922, but the only commercial output consisted of blocks and slabs from the stock of the old Colorado Yule Marble Co. The companies at this place are the Carrara Yule Marble Co. (address, Marble), formerly the Colorado Yule Marble Co., which did development work and quarried some stone but made no shipments; the Colorado Marble Co. (address, Kansas City, Mo.) and the Colorado White Marble Co. (address, Glenwood Springs), which did development work only; and the Yule Marble Co. of Colorado (address, Marble), which operated a quarry and the mills formerly owned by the Colorado Yule Marble Co. and made sales of old stock only. Marble from these quarries is sold as "Colorado Yule," "Colorado Golden Veined," and "White Colorado." A deposit of marble of various shades is being developed at Villa Grove, Saguache County, by the Colorado Decorative Marble Co., of Denver, but no stone has yet been sold.

Georgia.—The Georgia Marble Co., of Tate, and the Alden Marble Co., of Whitestone, Pickens County, Ga., were the only operators of marble quarries in that State for building and monumental stone in 1922. The marble of the Georgia Marble Co. is sold under the trade names "Kenesaw," "Silver Gray," "Cherokee," "Etowah" ("Georgia Pink"), "Mezzotint," and "Creole." The greater part of the waste stone of this company is crushed and sold by the Georgia Mineral Products Co. of Tate. The North Georgia Marble Products Co. and the Alden Marble Co., of Whitestone, and the Willingham Stone Co.,

of Atlanta, are also selling various crushed-marble products from quarries in Pickens County. In 1922 stone from the Tate quarries was used in exterior work for the Federal Reserve Bank building, Atlanta, Ga., and the Kansas City mausoleum, Kansas City, Mo., and for interior work in the First National Bank building, Grove City, Pa., and the Colonial Trust building, Farrell, Pa.

Maryland.—The quarries on the property of the Beaver Dam Marble Co., at Cockeysville, Baltimore, Md., were the only white marble quarries operated in Maryland in 1922. The product is used for exterior building and interior decoration and for crushed stone. The Cardiff Green Marble Co. operated serpentine quarries for terrazzo, stucco, and crushed stone.

Massachusetts.—The quarries of the Lee Marble Works and the White Marble & Terrazzo Co., at Lee, Berkshire County, Mass., produced in 1922 building and monumental stone for stucco and terrazzo. The quarries of D. U. Smith, at Ashley Falls, and of the Hoosac Marble Co., at North Adams, produced only crushed and pulverized stone for chemical use, poultry grit, stucco, and terrazzo. The Westfield Marble & Sandstone Co. quarried serpentine.

Michigan.—(See Serpentine, p. 308.)

Missouri.—Marble sold in Missouri in 1922 included that from the quarries of the Phenix Marble Co., at Phenix, Greene County, and the better grade of stone quarried at Carthage, Jasper County. The stone from Phenix is known to the trade as "Napoleon Gray" and "Phenix." It is characterized by fossil shells and fine wavy stylolites, or "crowfeet," which resemble those in the Tennessee marbles. It is widely used for interior building in the form of tiles, wainscoting, and slabs and is also used for exterior building work, for furnace flux, and for burning into lime. The quantity of this stone sold in this region during the last five years[6] has been as follows: 1918, 86,508 cubic feet; 1919, 106,621 cubic feet; 1920, 138,775 cubic feet; 1921, 135,084 cubic feet; 1922, 178,811 cubic feet. The marble from the Carthage district is known as "Ozark Gray," "Colonial Gray," "Carthage Marble," etc. The output of marble and limestone and the producers are shown on page 319. In 1922 marble was sold for building stone from quarries opened at Ozora, Ste. Genevieve County, by the Ozora Marble Quarries Co. The Consolidated Marble Co. also opened a quarry at Ste. Genevieve. The stone at Ste. Genevieve is known as "Ste. Genevieve Golden Vein" and "Ste. Genevieve Rose."

New Jersey.—(See Serpentine, p. 309.)

New Mexico.—In New Mexico the marble property operated by the Alamoro Marble Co., at Alamogordo, Otero County, has been worked on a small scale for many years. In 1922 rough blocks were shipped for use in interior work in the addition to the State capitol at Santa Fe. The stone is sold as "Alamoro Golden Vein," "Alamoro Golden Fleuri," "Alamoro Gray Vein," and Alamoro Gray Fleuri."

New York.—The active marble quarries in New York in 1922 were those of the Vermont Marble Co. (address, Proctor, Vt.), at Plattsburg (Bluff Point quarry), Clinton County; the South Dover Marble Co. (address, New York City), at Wingdale, Dutchess County; and the

[6] Published by permission of the Phenix Marble Co.

Gouverneur Marble Co. and John J. Sullivan, at Gouverneur, St. Lawrence County. The black marble quarried at Glens Falls was all used for foundations and crushed stone in 1922 and is included under limestone. The Kapailo Manufacturing Co. and the Benedict Stone Co. use the marble at Tuckahoe, Westchester County, mainly for the manufacture of architectural concrete stone and stucco, and Conlin & Co., at Tuckahoe, crush the stone and sell it for various crushed-stone products. The Clinton County stone is sold as "Lepanto" and "York Fossil," the South Dover stone as "South Dover White," and the Glens Falls stone as "Glens Falls Black." In 1922 the South Dover stone was used in the construction of the National Academy of Sciences, at Washington, and the Hartford State Savings Bank, at Hartford, Conn.

North Carolina.—The Regal Blue Marble Co., of Atlanta, Ga., operated its quarry at Regal, Cherokee County, N. C. (post office Murphy), in 1922. The product is used entirely for monumental work and is sold as "Regal Blue."

Pennsylvania.—(See Serpentine, p. 309.)

Tennessee.—The well-known marbles quarried in eastern Tennessee are described in an extensive report prepared by the Tennessee Geological Survey in cooperation with the United States Geological Survey and now in press. One feature of this report will be a series of detailed topographic and geologic maps of the principal quarry districts in the marble belts. These maps will be on a sufficiently large scale to give adequate data for estimating reserves of marble where natural conditions for quarrying are best. Maps of this character should be increasingly useful in many quarry districts, especially those older districts in which the gradual exhaustion of present quarries and the extension of real-estate improvements render an inventory of local reserves of growing importance. The usefulness of geologic maps of mines and the immediate country surrounding them has long been recognized, and, although they will not on the whole be of so vital interest in stone quarrying as in mining, they have not received the attention which they deserve.

Besides the main marble deposits there is a smaller deposit of reddish-brown or liver-colored marble within the neighboring shale formation, but weathering has disclosed that much of this marble contains numerous streaks or partings of shaly material.

No shipments were made from the marble property at Gin Hollow, 2½ miles northeast of Flintville, Lincoln County, owned by the National Marble Co. of Tennessee (address, Nashville, Tenn.).

The marble operations in Blount, Knox, and Union counties, Tenn., continued to be the second largest in the United States. The companies operating in 1922 are given below.

Blount County:
  Friendsville:
    John J. Craig Co. (address, Knoxville).
    Tennessee Producers Marble Co. (address, Knoxville).
  Louisville: Light Pink Marble Co.; "Anderson Pink."
Knox County:
  Knoxville:
    Appalachian Marble Co.
    Bond Marble Co.
    Consolidated Marble Co.
    Gray Eagle Marble Co.
    Gray Knox Marble Co.

Knox County—Continued.
Knoxville—Continued.
Knoxville Marble Co.
Ross-Republic Marble Co.
Tennessee Producers Marble Co.
Thrasher Marble Co.
Union County:
Luttrell: Ross-Republic Marble Co. (address, Knoxville).

The Tennessee marble is used chiefly for interior building work, but it is used also for monuments and exterior building. A considerable quantity of the waste stone is sold to lime manufacturers in the neighborhood of Knoxville. It was reported that new quarries in the Knoxville district would be in operation in 1923. The marbles from this State are of various shades of gray, pink, brown, and red-brown. Nearly all the gray and pink marbles have very distinctive black markings (stylolites, or "crowfeet") and are generally known to the trade by the name of the quarry qualified by the color of the stone. The Light Pink Marble Co. produces stone that does not have these stylolites.

Texas.—The only marble produced in Texas in 1922 came from the quarries of the Vermont Marble Co. (address, Proctor, Vt.) at San Saba, San Saba County. It is stated that these quarries will be closed. This stone has been used for interior work, mostly in banks, since 1915. Some of the recently erected buildings with interior work of this stone are the Bank of Commerce, San Antonio, Tex. (1917); American Exchange National Bank, Dallas, Tex. (1918); First National Bank, Wichita, Kans. (1922); Citizens & Manufacturers National Bank, Waterbury, Conn. (1922); and National Deposit Bank, Brownsville, Pa. (1922).

Utah.—The Birdseye quarries of the Mount Nebo Marble Co., at Thistle, Utah County, Utah, were worked in 1922. This marble is used entirely for interior decoration and is known as "Nebo Golden Travis." In 1922 stone from these quarries was used for interior work in the Western States Bank, Los Angeles, Calif.

Vermont.—Vermont produces more marble than any other State, and the stone includes so many varieties that it finds use as exterior and interior building stone of all kinds and in tombstones, monuments, mausoleums, stucco, terrazzo, and crushed stone, and it is also used in the manufacture of lime. The great variety of colors found in the Vermont marble quarries precludes the listing here of the trade names. The general color of the stone is white, modified by various markings of gray, black, or green. Colored marbles are also found. At Swanton, Franklin County, the marble quarried is of various shades of red and reddish brown and is used mostly for floor tiling. At Isle La Motte, Grand Isle County, the stone is black and grayish black with a few spots of white, and with occasional large gastropod shells. At Roxbury, Washington County, dark-green serpentine with many white veinlets is quarried. A very complete list and description of these marbles may be found in a report of the State geologist.[7]

The producing companies in 1922 were as follows:

Addison County:
Middlebury: Middlebury Marble Co. (address, Brandon); crushed stone.

[7] Perkins, G. H., Vermont State Geologist Ninth Rept., for 1913–14, pp. 178–218, 1914.

Bennington County:
East Dorset: Manchester Marble Co.
South Dorset: Imperial Marble Corporation (address, West Rutland).
Franklin County:
Swanton: Vermont Marble Co. (address, Proctor).
Grand Isle County:
Isle La Motte: Vermont Marble Co. (address, Proctor).
Rutland County:
Brandon, Danby, Pittsford, Proctor, and West Rutland: Vermont Marble Co. (address, Proctor).
West Rutland: Clarendon Marble Co.
Washington County:
Roxbury: Vermont Marble Co. (address, Proctor).

Virginia.—Marble quarried at Eagle Rock, Botetourt County, Va., was crushed for sale as terrazzo and stucco in 1922 by the Virginia Marble Co.

SERPENTINE.

The figures showing sales of serpentine (verde antique) in the United States for interior and exterior building, dimension stone, and by-products are included in this report under marble; but those showing sales of serpentine as crushed stone for road metal and ballast, riprap, foundation stone, and other low-grade material and as especially prepared crushed stone for terrazzo, stucco, granules, and flour are included under "miscellaneous" stone. All these uses are represented in the following table:

Serpentine (verde antique) sold in the United States in 1921 and 1922.

	1921		1922	
	Quantity.	Value.	Quantity.	Value.
Building and ornamental stone.....cubic feet..	37,370	$149,474	35,510	$142,988
Rough construction, crushed, etc.....short tons..	96,960	141,494	18,387	108,284
	.....	290,968	.....	251,272

California.—Serpentine has never been produced in California to any great extent. The deposit at Avalon, on Santa Catalina Island, has for several years yielded small quantities for interior building, ornamental work, and electrical switchboards, but it was not operated in 1922.

Maryland.—Serpentine quarried by the Cardiff Green Marble Co., at Cardiff, Harford County, Md., known as "Cardiff Green," was used for stucco and terrazzo, and the waste product was sold for ballast, road work, and dust or "flour."

Massachusetts.—The Westfield Marble & Sandstone Co., of Westfield, Hampden County, Mass., quarried black and green serpentine, which was sold in rough blocks, the greater part for interior building. This stone is known as "Westfield Green."

Michigan.—Development work was continued by the Michigan Verde Antique Marble Co. at its serpentine quarry near Ishpeming, Marquette County, in 1922. The serpentine deposit forms a low oval hill partly covered by a thin mantle of glacial drift. The quarry, which was opened in 1915, is still shallow and has hardly penetrated below the much jointed superficial part of the ledge, and

massive sound stone is interrupted by bands of broken material. This broken material and waste from the channeling of massive stone are crushed to different sizes and sold mainly for terrazzo and roofing granules. The stone from the quarry is conveyed over a private railroad 2 miles long to the mill, from which the finished products are shipped. The stone has a rather fine grained dark grayish-green groundmass, which polishes to a brilliant dark green, cut by three systems of intersecting veinlets. Veinlets of light-green serpentine are cut and slightly offset or faulted by veinlets of white dolomite, which are in turn cut and offset by streaked veinlets of ferruginous dolomite and light-green serpentine. Only a small quantity of the verde antique has been used thus far. The stone has been used in the Ishpeming Hospital.

New Jersey.—The serpentine reported from New Jersey in 1922 was quarried near Phillipsburg, Warren County, by the Rock Products Co., of Easton, Pa. The product was sold for interior work, stucco, and terrazzo. In 1922 it was used for interior work in the Easton Trust Building, Easton, Pa. This property has also been worked for talc.

Pennsylvania.—Serpentine deposits at Easton, Northampton County, Pa., were worked by the Rock Products Co., of Easton, in 1922, and the product was used for terrazzo, stucco, and roofing granules. Serpentine from this vicinity has also been quarried and sold for interior and exterior building work, but none was reported for this purpose in 1922.

Vermont.—The Vermont Marble Co. furnishes the entire serpentine output for Vermont. The quarries are at Roxbury, Washington County, and the product is sold for interior building.

Wyoming.—The Wyoming Asbestos Producing Co., of Casper, Natrona County, Wyo., reported for 1922 the production of a small quantity of serpentine from a deposit near Casper. This material was crushed and used as aggregate in concrete stone for chimney blocks.

LIMESTONE.

GENERAL SUMMARY.

The output of limestone as covered by this report was 29 per cent more in 1922 than in 1921. All the important items showed increase except stone sold for use by sugar refiners and for the liming of land, which decreased 35 and 9 per cent, respectively. Burned lime for agricultural use also decreased. The largest gain was in the quantity of stone sold for fluxing, which increased 76 per cent after a slump of 57 per cent in 1921. Building stone increased 57 per cent, rubble 52 per cent, rip rap 7 per cent, crushed stone 14 per cent, stone sold to glass works 40 per cent, stone sold to paper mills 24 per cent, and stone sold for miscellaneous uses, including refractories and other manufacturing industries, 39 per cent.

Limestone sold in the United States in 1921 and 1922, by uses.

Use.	1921		1922	
	Quantity.	Value.	Quantity.	Value.
Building stone.....cubic feet..	8,019,700	$7,886,586	[a]12,617,380	[a]$12,418,873
Approximate equivalent in short tons.....	621,500	.....	[a]955,540	.....
Curbing, flagging, and paving.....cubic feet..	33,930	33,804	(a)	(a)
Approximate equivalent in short tons.....	2,700	.....	(a)	.....
Rubble.....short tons..	188,000	280,067	286,340	470,264
Riprap.....do....	941,730	1,003,399	1,010,850	925,760
Crushed stone.....do....	28,720,410	32,232,438	32,786,300	33,224,879
Fluxing stone.....long tons..	9,503,830	9,428,767	16,687,740	14,208,457
Equivalent in short tons.....	10,644,290	.....	18,690,270	.....
Sugar factories.....short tons..	570,840	1,019,288	371,430	634,511
Glass works.....do....	118,970	232,715	166,070	291,854
Paper mills.....do....	120,460	223,601	149,430	264,130
Agriculture.....do....	1,311,520	2,355,339	1,195,000	2,150,435
Other uses[b].....do....	2,380,580	3,053,590	3,317,430	3,808,764
Total (quantities approximate, in short tons)....	45,621,000	57,749,594	58,928,660	68,397,927

[a] Figures for building stone include small amounts for monuments, curbing, and flagging.
[b] See table on p. 314 for further distribution of limestone products.

Limestone sold in the United States in 1921 and 1922, by States.

[Quantities approximate.]

State.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
Alabama	519,370	$737,513	830,160	$787,040
Arizona	(a)	(a)	59,250	52,597
Arkansas	206,020	216,987	80,810	72,803
California	198,020	406,441	216,520	384,732
Colorado	301,690	367,771	393,260	381,269
Connecticut	(a)	(a)	6,220	22,737
Florida	564,240	471,895	770,140	706,644
Georgia	143,050	355,796	161,980	424,242
Hawaii	3,290	7,394	.....	.....
Idaho	44,580	79,392	35,410	67,637
Illinois	4,256,580	4,298,402	6,690,010	6,423,573
Indiana	2,489,890	8,985,036	2,775,740	13,203,146
Iowa	417,890	516,730	620,710	657,126
Kansas	377,550	672,357	633,590	853,436
Kentucky	1,523,890	1,755,505	1,442,580	1,653,506
Louisiana	(a)	(a)	(a)	(a)
Maine	38,250	90,862	45,310	99,611
Maryland	356,760	462,454	439,730	459,528
Massachusetts	43,070	278,932	60,810	234,031
Michigan	5,395,780	3,387,722	7,646,550	4,533,998
Minnesota	200,850	531,302	250,950	583,467
Mississippi	(a)	(a)	(a)	(a)
Missouri	1,349,540	2,269,457	1,559,880	2,409,202
Montana	94,010	85,666	183,100	153,900
Nebraska	148,880	202,266	182,960	231,195
Nevada	(a)	(a)	(a)	(a)
New Jersey	228,600	280,761	264,340	320,855
New Mexico	(a)	(a)	(a)	(a)
New York	5,374,910	6,989,231	5,859,430	6,512,291
North Carolina	83,560	141,882	112,860	157,911
Ohio	6,986,430	6,833,921	8,800,680	7,473,525
Oklahoma	877,140	970,028	1,130,360	1,197,082
Oregon	(a)	(a)	(a)	(a)
Pennsylvania	6,713,240	8,346,138	9,736,470	9,848,290
Porto Rico	77,260	126,088	90,480	202,710
Rhode Island	(a)	(a)	(a)	(a)
South Dakota	24,880	42,000	19,340	32,795
Tennessee	874,750	1,107,169	1,024,850	1,239,359
Texas	939,170	956,519	1,238,780	1,074,373
Utah	372,510	474,671	411,000	355,643
Vermont	25,130	96,642	17,610	59,008
Virginia	1,157,160	1,308,246	1,368,230	1,527,430
Washington	25,480	49,541	40,380	94,810
West Virginia	1,582,790	1,651,137	2,157,250	2,126,265
Wisconsin	1,223,570	1,539,891	1,326,700	1,401,820
Wyoming	107,730	224,668	101,230	191,124
Undistributed	273,790	431,181	143,000	187,216
	45,621,000	57,749,594	58,928,660	68,397,927

[a] Included under "Undistributed."

Limestone sold in the United States in 1922, by States and uses.

State.	Number of active plants.	Building.[a]						Rubble.		Riprap.		Crushed stone.			
		Rough construction.		Rough architectural.		Dressed.						Concrete and road metal.		Railroad ballast.	
		Short tons.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama	13			8,470	$5,080	41,430	$51,765	370	$1,667	24,530	$17,294	25,140	$28,869		
Arizona	4													(b)	(b)
Arkansas	3											(b)	(b)	(b)	(b)
California	22	(b)	(b)							(b)	(b)	82,380	86,381	(b)	(b)
Colorado	13											45,400	48,684		
Connecticut	1														
Florida	9	1,800	$3,000									587,050	482,568	(b)	(b)
Georgia	9											92,570	152,432	(b)	(b)
Idaho	4														
Illinois	70	7,200	8,530	(c)	(c)	c 14,910	c 22,875	17,760	28,066	291,060	297,665	4,650,970	4,445,454	609,100	$501,650
Indiana	91			4,219,020	2,466,777	5,441,180	8,885,913	(b)	(b)	61,330	32,941	1,625,930	1,488,107	177,620	138,524
Iowa	37	5,180	6,720	(b)	(b)	(b)	(b)	10,980	14,099	106,970	107,833	417,550	451,943	5,640	5,171
Kansas	46	5,100	6,900			(b)	(b)	6,760	8,679	14,810	12,779	389,670	584,199	205,690	201,571
Kentucky	64	15,050	13,829	(c)	(c)	c 94,900	c 145,278	9,170	9,160	4,280	5,480	777,740	927,500	582,690	490,841
Louisiana	1											(b)	(b)		
Maine	3											(b)	(b)	(b)	(b)
Maryland	16	(b)	(b)	(b)	(b)							218,260	260,308	500	500
Massachusetts	4														
Michigan	21	(b)	(b)					(b)	(b)	(b)	(b)	1,024,110	662,781	38,300	33,024
Minnesota	16	600	1,300	40,400	37,723	119,820	235,502	9,570	11,721	26,450	18,578	193,080	258,983		
Mississippi	1														
Missouri	84	5,790	11,271			142,820	161,626	177,460	323,887	115,900	137,713	967,230	1,354,582	135,910	135,930
Montana	6											43,560	46,329	(b)	(b)
Nebraska	7							(b)	(b)	28,440	30,515	141,210	177,825		
Nevada	2														
New Jersey	14											43,980	71,143		
New Mexico	1													(b)	(b)
New York	77	97,350	101,663	(b)	(b)	(b)	(b)	1,440	2,346	6,550	9,256	3,849,870	4,529,723	827,860	748,148
North Carolina	4											91,440	117,184		
Ohio	119	21,020	41,642	(b)	(b)	(b)	(b)	(b)	(b)	16,960	15,848	4,949,330	4,302,281	469,940	406,286
Oklahoma	18							11,130	6,175	12,270	9,472	816,410	943,812	289,570	235,673
Oregon	2														
Pennsylvania	279	36,040	50,709					(b)	(b)			2,874,090	3,364,085	114,070	142,525

[a] Figures for building stone include small amounts for monumental work, curbing, and flagging.
[b] Included under "Undistributed."
[c] Rough architectural stone included under dressed stone.

Limestone sold in the United States in 1922, by States and uses—Continued.

State.	Number of active plants.	Building.						Rubble.		Riprap.		Crushed stone.			
		Rough construction.		Rough architectural.		Dressed.						Concrete and road metal.		Railroad ballast.	
		Short tons.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Porto Rico	11											79,280	$162,278		
Rhode Island	1														
South Dakota	4									(b)	(b)	12,500	22,332		
Tennessee	30									8,860	$6,224	528,590	557,359	294,590	$236,749
Texas	17	(b)	(b)	d 26,640	d $23,335	(d)	(d)	(b)	(b)	31,570	32,837	976,680	868,761	167,760	90,687
Utah	14	(b)	(b)	(b)	(b)			(b)	(b)	(b)	(b)	16,660	13,161	(b)	(b)
Vermont	8	(b)	(b)									2,160	1,335		
Virginia	44							(b)	(b)	(b)	(b)	581,510	693,946	506,560	476,041
Washington	4														
West Virginia	29											569,530	580,980	86,730	72,772
Wisconsin	62	6,030	$15,520							53,540	56,316	1,072,040	1,101,047	74,200	72,975
Wyoming	7							7,890	$13,936	(b)	(b)	(b)	(b)		
Undistributed		9,530	10,259	17,820	14,748	28,170	$96,908	33,810	50,528	207,330	135,009	160,530	180,139	293,120	269,301
	1,292	210,690	271,343	4,352,030	2,577,416	5,843,550	9,570,114	286,340	470,264	1,010,850	925,760	27,906,450	28,966,511	4,879,850	4,258,368
Average value			1.29		0.59		1.64		1.64		0.92		1.04		0.87

State.	Number of active plants.	Fluxing stone.		Sugar factories.		Glass factories.		Paper mills.		Agriculture.		Other.		Total.	
		Long tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
Alabama	13	691,730	$679,574							(b)	(b)	(b)	(b)	830,160	$787,040
Arizona	4	39,510	50,097											59,250	52,597
Arkansas	3									(b)	(b)			80,810	72,803
California	22	21,610	54,800	(b)	(b)	(b)	(b)	(b)	(b)	18,610	$61,149	34,890	$108,707	216,520	384,732
Colorado	13	241,510	208,546	53,090	$94,908							(b)	(b)	393,260	381,269
Connecticut	1									6,220	22,737			6,220	22,737
Florida	9									(b)	(b)	(b)	(b)	770,140	706,644
Georgia	9	(b)	(b)							17,710	34,502	44,570	230,308	161,980	424,242
Idaho	4	(b)	(b)	(b)	(b)			(b)	(b)	(b)	(b)	(b)	(b)	35,410	67,637
Illinois	70	666,740	682,525			12,260	$13,414			263,240	293,894	90,410	129,500	6,690,010	6,423,573

Indiana	91	81,870	53,095	(b)	(b)	(b)	(b)			64,930	67,176	8,300	10,012	2,775,740	13,203,146
Iowa	37	(b)	(b)	8,100	11,670					59,720	49,226			620,710	657,126
Kansas	46									4,040	7,163	(b)	(b)	633,590	853,436
Kentucky	64	16,050	13,932							21,820	25,341	6,050	22,145	1,442,580	1,653,506
Louisiana	1													(b)	(b)
Maine	3	(b)	(b)					(b)	(b)	(b)	(b)			45,310	99,611
Maryland	16	(b)	(b)							(b)	(b)	5,420	18,785	439,730	459,528
Massachusetts	4	(b)	(b)							58,560	224,443	(b)	(b)	60,810	234,031
Michigan	21	4,297,190	2,390,692	62,070	75,961			50,520	$79,438	218,360	211,192	1,437,220	1,078,026	7,646,550	4,533,998
Minnesota	16	(b)	(b)							2,840	3,094	1,780	10,841	250,950	583,467
Mississippi	1									(b)	(b)			(b)	(b)
Missouri	84	33,440	41,319	(b)	(b)	30,450	46,757	(b)	(b)	23,960	36,122	50,720	156,845	1,559,880	2,409,202
Montana	6	113,570	86,315	(b)	(b)							(b)	(b)	183,100	153,900
Nebraska	7	(b)	(b)	(b)	(b)					(b)	(b)	(b)	(b)	182,960	231,195
Nevada	2	(b)	(b)	(b)	(b)							(b)	(b)	(b)	(b)
New Jersey	14	180,090	188,028							18,660	61,684			264,340	320,855
New Mexico	1													(b)	(b)
New York	77	186,040	162,570			(b)	(b)	19,020	24,239	70,860	211,292	776,430	708,085	5,859,430	6,512,291
North Carolina	4	(b)	(b)							21,010	40,077			112,860	157,911
Ohio	119	2,539,190	2,061,629			20,360	43,778			45,770	82,136	406,710	392,377	8,800,680	7,473,525
Oklahoma	18					(b)	(b)							1,130,360	1,197,082
Oregon	2							(b)	(b)	(b)	(b)			(b)	(b)
Pennsylvania	279	5,699,180	5,569,056			63,950	126,244	22,790	28,344	110,390	339,761	131,710	227,266	9,736,470	9,848,290
Porto Rico	11			(b)	(b)					(b)	(b)			90,480	202,710
Rhode Island	1	(b)	(b)									(b)	(b)	(b)	(b)
South Dakota	4			(b)	(b)									19,340	32,795
Tennessee	30	77,690	57,931							52,400	114,697	(b)	(b)	1,024,850	1,239,359
Texas	17	39,330	44,068			(b)	(b)			700	775	5,080	4,096	1,238,780	1,074,373
Utah	14	118,680	99,312	50,360	95,304							(b)	(b)	411,000	355,643
Vermont	8	(b)	(b)							14,200	52,285	300	3,679	17,610	59,008
Virginia	44	41,080	36,688							27,220	53,485	204,310	264,798	1,368,230	1,527,430
Washington	4	19,950	55,011					17,260	35,076	(b)	(b)	(b)	(b)	40,380	94,810
West Virginia	29	1,314,980	1,407,170							28,160	65,298	(b)	(b)	2,157,250	2,126,265
Wisconsin	62	51,920	48,719							31,190	43,093	23,660	50,214	1,326,700	1,401,820
Wyoming	7			95,860	188,402									101,230	191,124
Undistributed		216,390	217,380	101,950	168,266	39,050	61,661	39,840	97,033	14,430	49,813	89,870	393,080	143,000	187,216
	1,292	16,687,740	14,208,457	371,430	634,511	166,070	291,854	149,430	264,130	1,195,000	2,150,435	3,317,430	3,808,764	58,928,660	68,397,927
Average value			0.85		1.71		1.76		1.77		1.80		1.15		1.16

b Included under "Undistributed."

d Dressed stone included under rough architectural stone.

Limestone sold in the United States for miscellaneous uses in 1921 and 1922.

Use.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
Alkali works	1,738,280	$1,465,580	2,494,260	$1,878,702
Calcium carbide works	227,260	129,641	256,190	117,939
Refractories	79,480	85,786	146,640	172,251
Whiting substitute	29,560	264,244	66,200	405,783
Magnesia works	32,050	60,648	53,170	79,313
Asphalt filler	128,120	532,621	138,930	549,281
Mineral wool	(a)	(a)	9,170	10,622
Carbolic-acid works	13,520	22,293	3,950	3,707
Carbonic-acid works	35,830	134,363	26,890	53,357
Poultry grit	11,780	69,055	10,792	71,213
Lime burners	(a)	(a)	8,100	4,292
Stucco	24,170	126,188	62,870	382,792
Paving and curbing	2,700	33,804	(b)	(b)
Roofing gravel	1,550	7,733	(a)	(a)
Other uses c	58,980	155,438	40,268	79,512
	2,383,280	3,087,394	3,317,430	3,808,764

a Included under "Other uses."
b Included under building stone.
c Also includes stone sold for manufacture of sulphuric acid, phosphates, terrazzo, artificial stone, ammonia, nitrates, soap, baking powder, the purification of copper, filter stone, and uses not specified.

The limestone represented in this report does not include that burned into lime or made into cement. These commodities are treated in separate chapters, and the limestone used in their manufacture is estimated in the following table.

Limestone used for all purposes in the United States, 1920–22, in short tons.

Use.	1920	1921	1922
Limestone (as given in this report)	59,290,000	45,621,000	58,928,660
Portland cement (including "cement rock")	24,747,000	24,400,000	30,070,000
Natural cement ("cement rock")	128,600	90,000	148,000
Lime	7,140,000	5,060,000	7,280,000
	91,305,600	75,171,000	96,426,660

BUILDING STONE.

About 50 per cent of the building stone sold in 1922 was limestone. Sales of this limestone were confined to a few special districts, which are considered below.

INDIANA.

The output of building stone in Indiana was 40 per cent of all building stone sold in the United States in 1922 and 76 per cent of the total limestone sold for building. The chief producing centers in the oolitic limestone belt are in the vicinity of Bedford and Bloomington, Lawrence and Monroe counties. This stone is sold mainly for exterior building, including carved and other ornamental work. For interior work it is used for altars, mantels, wainscoting, benches, and stairways and to a minor extent for floors. A small quantity is also sold for monuments. Very little of the regular run of quarry of gray or buff stone is rubbed or polished, but the hard buff

stone from certain beds in some quarries takes a very good polish and is sold under the name "Wellington Cream." Coarse-grained stone with natural cavities due to the presence of unfilled fossil shells is sawed with or across the grain and sold as "Indiana Travertine." It is suitable for both exterior and interior work and is offered for the same use as imported limestones and monotone marbles. Other coarse-grained stone without the cavities is sold as "Rustic."

The output of building stone from this district in 1922 was the largest since 1912 and showed a gain of 82 per cent over the quantity sold in 1921.

Limestone quarried and sold in the Bedford-Bloomington district, Lawrence and Monroe counties, Ind., in 1922.

County.	Number of active plants.	Building stone.[a]					
		Rough blocks.		Sawed.		Dressed.	
		Cubic feet.	Value.	Cubic feet.	Value.	Cubic feet.	Value.
Lawrence	10	3,044,741	$1,894,933	1,650,035	$1,612,969	1,461,203	$4,584,207
Monroe	20	1,144,806	548,274	1,985,709	1,814,929	330,176	833,511
	30	4,189,547	2,443,207	3,635,744	3,427,898	1,791,379	5,417,718
Average value			0.58		0.94		3.02
Total, 1921	31	2,253,085	1,499,135	1,799,655	1,883,304	1,244,718	3,433,420

County.	Number of active plants.	Total building stone.		Other.		Total.	
		Cubic feet.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
Lawrence	10	6,155,979	$8,092,109	192,611	$134,577	639,000	$8,226,686
Monroe	20	3,460,691	3,196,714	22,111	4,656	273,000	3,201,370
	30	9,616,670	11,288,823	214,722	139,233	912,000	11,428,056
Average value			1.17		0.65		
Total, 1921	31	5,297,458	6,815,859	141,068	146,425	525,000	6,962,284

[a] Includes a small amount of stone sold for monumental work, curbing, and flagging.

The stone quarried in this district is sold by the quarrymen in the form of rough blocks, sawed blocks, and dressed or cut stone. In 1922 more than 44 per cent of the stone sold by the quarrymen consisted of rough blocks, of which 36 per cent (1,508,100 cubic feet) was sold by the quarrymen to mills in the district, where the stone was sawed or cut, dressed, and shipped to other parts of the country.

The value of the stone sold by the mills was $3,706,900. Thus the total gross value of the building stone sold in this district, including the value added to the product by manufacturers, was about $15,000,000. The rough blocks sold by the quarrymen in 1922 represented a gain of 86 per cent over 1921. The average value decreased from 67 cents a cubic foot in 1921 to 58 cents in 1922. The sawed stone sold a little more than doubled in quantity, but its average value per cubic foot decreased from $1.05 in 1921 to 94 cents in 1922. The dressed stone sold increased 44 per cent in quan-

tity, and its average value per cubic foot increased from $2.76 in 1921 to $3.02 in 1922.

Notwithstanding reports from some of the producers that prices remained about the same in 1922 as in 1921, only a slight advance having been made in the last part of the year, and that the cost of fuel and other raw materials increased operating expenses, the average value of all building stone sold decreased from $1.29 in 1921 to $1.17 in 1922. Regarding this condition Mr. H. S. Brightly, technical director, Indiana Limestone Quarrymen's Association,[8] makes the following statement:

> The increased average for cut stone was fully justified by labor and other increases in production costs. * * * While the average price for the rough stone shows a reduction of about 5 per cent from the 1921 average, the average selling price charged for the various grades by the quarry operators during 1922 was actually higher than in 1921, the lower average value for 1922 being accounted for by the production and shipment of a much larger proportion of the lower-priced grades than in 1921. This shows a healthy condition of the quarry industry, because it means that a larger proportion of the merchantable stone is being marketed, and in utilizing a greater volume of the lower-priced grades it also indicates that some reduction has been effected in the amount of sound stone that has been wasted in previous years on account of minor blemishes. An increasing amount of "variegated," "rustic," and "standard" stock was sold in 1922, and the demand for this class of stone seems to be on the increase.

The waste product of some of the quarries is sold in small quantities and at comparatively low prices for use as riprap, furnace flux, road metal and ballast, and for agricultural use. Other waste stone is more carefully selected and sold to glass works, pulverized for use as agricultural limestone, and crushed for use in concrete and road making. The stone for road making, however, is mainly the hard, dense rock that forms the overburden of many of the quarries. The quantity of the stone sold for these miscellaneous uses in 1922 increased 52 per cent over that sold in 1921. The average value per ton in 1922 was 65 cents; in 1921 it was $1.04. The figures given do not include stone that was burned into lime in the district.

The sales of stone by the mills of the district and the shipments of stone from the State by the quarries and mills are given in the following tables. Several of the quarry operators also operate mills, but their entire product is included under quarry shipments. In reading the table of shipments it must be remembered that although stone may be billed from the district to a certain State it may have been received by a cut-stone contractor who shipped it to another State.

Indiana oolitic limestone sold by the mills in the Bedford-Bloomington district, Lawrence and Monroe counties, Ind., 1917–1922.

Year.	Cubic feet.	Value.	Year.	Cubic feet.	Value.
1917	1,471,101	$1,788,405	1920	833,298	$2,112,384
1918	624,736	647,851	1921	1,030,177	2,691,931
1919	686,712	1,156,168	1922	1,508,100	3,706,900

[8] Letter, May 5, 1923.

Indiana oolitic limestone shipped to different States and Canada in 1922, in cubic feet.

Destination.		By milling companies.	By quarry companies.	Total.
Alabama		----	46,529	46,529
Arkansas		----	32,535	32,535
California		----	35,954	35,954
Colorado		----	13,742	13,742
Connecticut		27,515	4,889	32,404
Delaware		31	----	31
District of Columbia		47,302	110,078	157,380
Florida		----	10,192	10,192
Georgia		7,233	35,381	42,614
Illinois		318,753	1,725,098	2,043,851
Indiana [a]	gross	100,294	2,413,016	2,513,310
	net	100,294	904,916	1,005,210
Iowa		23,450	171,279	194,729
Kansas		2,436	55,966	58,402
Kentucky		6,201	116,907	123,108
Louisiana		2,119	34,320	36,439
Maine		1,487	----	1,487
Maryland		5,277	33,685	38,962
Massachusetts		22,290	208,234	230,524
Michigan		47,712	789,567	837,279
Minnesota		12,174	188,173	200,347
Mississippi		----	20,221	20,221
Missouri		18,261	157,668	175,929
Nebraska		9,552	105,571	115,123
New Hampshire		76	----	76
New Jersey		34,648	234,978	269,626
New Mexico		1,013	962	1,975
New York		66,314	1,235,225	1,301,539
North Carolina		18,989	108,955	127,944
North Dakota		4,424	533	4,957
Ohio		279,810	563,707	843,517
Oklahoma		1,800	108,238	110,038
Pennsylvania		332,440	487,723	820,163
Rhode Island		12,210	4,950	17,160
South Carolina		1,224	13,728	14,952
South Dakota		2,371	41,581	43,952
Tennessee		5,109	69,110	74,219
Texas		5,928	37,210	43,138
Virginia		23,671	37,152	60,823
Washington		----	5,000	5,000
West Virginia		26,563	31,064	57,627
Wisconsin		22,149	195,318	217,467
Wyoming		----	12,310	12,310
Canada		17,274	293,573	310,847
		1,508,100	[b] 9,790,322	11,298,422

[a] "Gross" includes, under quarry companies and State total, shipments to mills in the district (1,508,100 cubic feet) and to other quarry companies (173,652 cubic feet); "net" includes sales of rough and dressed stone to consumers other than mills in the Bedford-Bloomington district.

[b] Includes 173,652 cubic feet of stone purchased, dressed, and resold.

The quarry operators in this district in 1922 were as follows:

Lawrence County:

Bedford:

Bedford Ground Limestone Co.; crushed stone.

Bedford Stone Products Co.; stone bought from different quarries, crushed and sold for various uses.

Consolidated Stone Co.; Dark Hollow quarry and mill, Dugan mill, Bedford mill.

Doyle Stone Co. (Inc.) (address, 103 Park Ave., New York City); quarry.

Furst-Kerber Cut Stone Co. (address, 2301 South LaSalle Street, Chicago); quarry and mill.

Imperial Stone Co.; quarry.

Indiana Quarries Co. (address, 112 West Adams Street, Chicago); quarries and mills, also riprap, crushed stone, and lime.

Ingalls Stone Co.; Robin Roost, Peerless Station, and Royal Blue quarries and mills.

W. McMillan & Son; Reed quarry and mill; Peerless quarry and mill.

Shea & Donnelly Co.; quarry and mill.

Lawrence County—Continued.
Mitchell: Lehigh Lime Co. (address, Conway Building, Chicago); crushed stone and lime.
Oolitic: Indiana Quarries Co. (See above, under Bedford.)
Monroe County:
Bloomington:
Bloomington-Bedford Stone Co.; quarry and mill.
Consolidated Stone Co. (address, Bedford); Hunter Valley quarry and mill.
Crescent Stone Co.; quarry and mill.
Hunter Bros. Stone Co.; quarry and mill
Hunter Valley Stone Co.; quarry.
W. McMillan & Son (address, Bedford); mill.
Mathers Stone Co. (address, 437 Postal Telegraph Building, Chicago); quarry and mill.
Monroe County Oolitic Stone Co.; quarry and mill.
National Stone Co.; quarry and mill.
Star Stone Co. (address, 112 West Adams Street, Chicago); quarry and mill.
Clear Creek:
Oolitic Operative Quarries Co. (address, Bloomington); quarry and mill.
United Indiana Stone Co. (address, Bloomington); Crown quarry and mill.
Ellettsville:
Alexander King Stone Co. (address, Bloomington); Breyfogle quarry and mill.
Perry Stone Co.; quarry and mill.
Sanders:
Chicago & Bloomington Stone Co. (address, Bloomington); quarry and mill.
Bowman-King Stone Co. (address, Bloomington); quarry and mill.
Empire Stone Co.; quarry and mill.
W. McMillan & Son (address, Bedford); quarry.
Stinesville:
J. Hoadley & Sons Co. (address, Bloomington); quarry and mill.
Swenson Stone Co. (address, Urbana, Ill.); quarry and mill.
Victor: Reed-Powers Cut Stone Co. (address, Bedford); quarry and mill.

The mills in operation in 1922, other than those operated by quarry owners, were as follows:

Bedford:
Bedford Cut Stone Co.
Brooks Cut Stone Co.
J. P. Falt Co.
Hoosier Cut Stone Co.
Inter-State Cut Stone Co.
John A. Rowe Cut Stone Co.
Henry Struble Cut Stone Co.
Bloomington:
Central Oolitic Stone Co.
Hoadley Stone Co.
Matthews Bros Co.
James H. Nolan & Sons Co.
H. A. Woolery & Son.
Ellettsville:
Harding & Cogswell (Inc.)
Sterling Oolitic Stone Co.

MISSOURI.

Next to Indiana the Carthage district, in Jasper County, Mo., furnishes the largest quantity of limestone for building. This stone is light gray, rather coarsely crystalline, and marked by fossil shells. Much of it possesses the quality of marble and is included under

marble in the figures of this report. The following table gives the total production of limestone and marble in the district for 1920, 1921, and 1922.

Limestone and marble sold in the Carthage district, Jasper County, Mo., 1920–1922.

Year.	Building stone (rough and dressed).		Monumental stone (rough and dressed).		Other.		Total.	
	Cubic feet.	Value.	Cubic feet.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
1920	295,341	$589,213	86,791	$158,440	56,292	$190,529	129,700	$938,182
1921	279,560	587,301	31,551	77,421	46,751	152,521	72,600	817,243
1922	368,400	692,693	26,330	40,471	68,550	176,852	102,300	910,016

A decrease in the quantity of monumental stone sold and an increase in the quantity of building stone and stone sold for rubble, crushed stone, flux, and stone for fillers marked the output of the Carthage district in 1922. The average value per unit of each of these commodities also decreased.

The producers of the district in 1922 were the Carthage Marble & Building Stone Co., Carthage Marble & White Lime Co., Consolidated Marble & Stone Co., Ozark Quarries Co., Spring River Stone Co., and F. W. Steadley & Co. for building and monumental stone; and the Carthage Crushed Limestone Co. and Independent Gravel Co. for crushed stone.

MINNESOTA.

In Minnesota the greater part of the output of building stone comes from Kasota, Le Sueur County, and Mankato, Blue Earth County.

Stone sold at Mankato and Kasota, Minn., 1920–1922.

Year.	Building stone (rough and dressed).		Other.		Total.	
	Cubic feet.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
1920	104,865	$132,170	39,564	$54,485	47,900	$186,655
1921	111,487	271,230	32,627	41,409	41,500	312,639
1922	151,110	261,275	29,910	32,329	42,600	293,604

Two colors of stone, pink and yellow, are found at Kasota. The stone is furnished to the building trade sawed with the bed of the stone and sawed across the bed and is sold as "Pink Kasota Fleuri," "Pink Kasota Veine," "Yellow Kasota Fleuri," and "Yellow Kasota Veine." The stone from Mankato is sold under the name "Kato Stone."

Building stone is also quarried at Mantorville, Dodge County, and near Winona, Winona County. The Winona stone is put on the market as "Biesanz American Travertine" and "Tracon."

The quarry operators for building stone in these districts are as follows:

Mankato, Blue Earth County:
T. R. Coughlan Co.
Fowler & Pay.
Mantorville, Dodge County:
Mantorville Stone Co.
Kasota, Le Sueur County:
Babcock & Wilcox.
Breen Stone & Marble Co.
Winona, Winona County:
Biesanz Stone Co.
George Haun Stone Co.

KENTUCKY.

The oolitic limestone quarried in Warren County, Ky., is well known to the building trade. The following table shows the production for the county from 1920 to 1922:

Limestone sold in Warren County, Ky., 1920–1922.

Year.	Building stone (rough and dressed).		Monumental stone (rough and dressed).		Other.		Total.	
	Cubic feet.	Value.	Cubic feet.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
1920	61,230	$66,800	37,470	$56,210	7,480	$12,420	15,600	$135,430
1921	117,000	145,790	11,000	24,750	6,230	5,840	16,800	176,380
1922	79,000	130,600	12,400	12,412	5,200	7,000	12,740	150,012

The principal producing companies at present are the Bowling Green Quarries Co., Bowling Green, and the Caden Stone Co., Hadley. There are also a few other producers, who sell mostly for local use and do not operate regularly.

OTHER STATES.

Limestone for building purposes other than local or rough contruction work is produced in a few other States, and the principal producing localities are as follows:

Alabama.—Foster & Creighton (address, Nashville, Tenn.) have for many years operated a quarry at Rockwood, Franklin County, Ala., for rough and dressed architectural stone. The production of this quarry for 1916 to 1922 was as follows:

Stone produced at Foster & Creighton quarry, Rockwood, Ala., 1916–1922.

Year.	Architectural stone.		Other.[a]		Total.	
	Cubic feet.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
1916	101,000	$42,664	120,800	$55,153	128,000	$97,817
1917	83,000	36,760	118,800	68,444	125,000	105,204
1918	30,000	35,000	63,000	42,500	65,000	77,500
1919	27,000	41,000	110,000	106,000	112,000	147,000
1920	25,300	25,291	143,000	162,643	145,000	187,934
1921	50,500	55,530	15,000	15,533	19,000	71,063
1922	50,000	56,845	97,000	72,101	101,000	128,946

[a] Includes stone for rubble, riprap, crushed stone for concrete and road metal, railroad ballast, agricultural limestone, and furnace flux.

The quarries of this company were taken over by the Government in July, 1918, and the output of stone was greatly curtailed. It was the plan of the Government to operate these quarries in connection with the nitrate plants in that vicinity, the stone being of the desired quality and the supply practically unlimited. A considerable amount of new machinery was placed in the quarries, and operations were begun on a large scale. The quarries were returned to the owners in March, 1919.

Illinois.—Limestone for buildings was quarried in Illinois at Quincy, Adams County, by the Roeder & Greeman Stone & Construction Co.; at Alton, Madison County, by Winthrop Schwallenstecker; and at Joliet, Will County, by Swan, Medin & Co.

Kansas.—Limestone quarried at Silverdale, Cowley County, Kans., has had considerable sale for building stone under the name "Silverdale Stone," but the quarries were not in operation in 1922.

Ohio.—The Wagner Quarries Co., Sandusky, Erie County, Ohio, reported sales of building stone, rubble, riprap, crushed stone, and agricultural limestone during 1922.

Texas.—Limestone was reported as quarried in Texas and sold for the better grades of building stone from the quarries of A. C. Fox, Lueders, Jones County; D. W. Casbeer, Lampasas, Lampasas County; and the Cedar Park Stone Co., Leander, Williamson County. The stone from Leander was sold as "American Cream White Lens."

Utah.—A fine-grained light-colored oolitic limestone has been quarried near Ephraim, San Pete County, Utah, and used in buildings in Salt Lake City and Provo, Utah, and in San Francisco. The present operators of quarries at Ephraim are the San Pete White Stone Co. and Jacob Peterson.

Other States.—Small amounts of limestone were quarried and sold as building stone in Iowa, Maryland, and New York.

SANDSTONE.

GENERAL SUMMARY.

There were increases in the sales of all sandstone products in 1922 except flagging and riprap, which declined 18 and 52 per cent, respectively. These products, however, were small parts of the total output, which showed an increase of 28 per cent. Crushed stone, which forms the greater part of the sandstone quarried, increased 27 per cent; ganister, which decreased 63 per cent in 1921, increased 79 per cent; building stone increased 5 per cent; paving blocks, which increased 20 per cent in 1921, made a further increase of 24 per cent.

Sandstone sold in the United States in 1921 and 1922, by uses.

Use.	1921		1922	
	Quantity.	Value.	Quantity.	Value.
Building stone.....cubic feet..	2,816,240	$1,612,039	2,966,400	$1,947,557
Approximate equivalent in short tons.....	229,410	.....	243,900	.....
Paving blocks.....number..	4,332,500	367,716	5,371,260	445,541
Approximate equivalent in short tons.....	43,740	.....	55,140	.....
Curbing.....cubic feet..	1,342,840	968,323	1,811,980	1,237,092
Approximate equivalent in short tons.....	108,110	.....	148,690	.....
Flagging.....cubic feet..	791,660	471,837	650,590	406,731
Approximate equivalent in short tons.....	65,100	.....	53,580	.....
Crushed stone.....short tons..	1,539,470	2,215,070	1,947,780	2,342,521
Riprap.....do....	216,430	211,458	103,040	99,155
Rubble.....do....	33,550	56,711	105,420	128,859
Ganister.....do....	404,650	522,185	724,860	881,314
Other.....do....	.....	.....	5,720	32,274
Total (quantities approximate, in short tons).....	2,640,460	6,425,339	3,388,130	7,521,044

Sandstone sold in the United States in 1921 and 1922, by States.

[Quantities approximate.]

State.	1921		1922	
	Short tons.	Value.	Short tons.	Value.
Alabama	22,200	$36,741	33,750	$41,395
Arizona	92,250	69,486	4,550	2,639
Arkansas	34,250	50,991	(a)	(a)
California	345,550	459,482	456,560	599,815
Colorado	27,760	41,178	32,740	41,695
Connecticut	(a)	(a)	(a)	(a)
Idaho	(a)	(a)	1,240	2,779
Illinois	74,040	54,558	91,300	49,993
Iowa	.....	.....	(a)	(a)
Kansas	1,130	2,788	24,070	42,040
Kentucky	49,860	121,982	95,110	200,345
Louisiana	.....	.....	1,070	1,068
Maryland	(a)	(a)	(a)	(a)
Massachusetts	2,350	49,095	2,260	56,342
Michigan	(a)	(a)	(a)	(a)
Minnesota	84,650	210,416	79,420	159,548
Missouri	.....	.....	920	12,279
Montana	(a)	(a)	(a)	(a)
New Jersey	30,760	44,146	10,200	13,200
New Mexico	310	552	194,000	113,140
New York	b 156,930	b 901,915	b 332,160	b 1,372,429
North Carolina	(a)	(a)	.....	.....
Ohio	242,720	1,729,601	336,800	2,091,115
Oklahoma	(a)	(a)	6,070	8,810
Pennsylvania	b 968,660	b1,775,148	b1,240,560	b 2,005,125
South Dakota	129,890	213,235	99,780	148,723
Tennessee	(a)	(a)	(a)	(a)
Utah	1,500	9,102	.....	.....
Virginia	(a)	(a)	52,870	17,420
Washington	6,780	72,325	(a)	(a)
West Virginia	26,410	50,960	6,220	8,679
Wisconsin	203,550	323,943	226,480	381,637
Wyoming	(a)	(a)	(a)	(a)
Undistributed	138,910	207,695	60,000	150,828
	2,640,460	6,425,339	3,388,130	7,521,044

a Included under "Undistributed." b Includes bluestone.

Sandstone sold in the United States in 1922, by States and uses.

State.	Number of active plants.	Building.						Ganister.		Paving blocks.		Curbing.	
		Rough construction.		Rough architectural.		Dressed.							
		Short tons.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Short tons.	Value.	Number.	Value.	Cubic feet.	Value.
Alabama	6	(a)	(a)					26,860	$33,225				
Arizona	2												
Arkansas	2												
California	12							360	811				
Colorado	12	1,200	$1,200	4,690	$3,255	850	$1,132	19,330	19,381			(a)	(a)
Connecticut	3	(a)	(a)										
Idaho	1			15,440	2,779								
Illinois	4	150	250					1,770	7,209				
Iowa	1	(a)	(a)										
Kansas	4	900	800										
Kentucky	7	3,000	5,797	14,580	7,236	127,680	112,814						
Louisiana	1												
Maryland	1							(a)	(a)				
Massachusetts	1			12,530	18,869	10,020	37,077						
Michigan	3	(a)	(a)			(a)	(a)						
Minnesota	7	4,340	4,500	1,630	2,298	1,000	1,400	1,010	597	273,870	$27,472	5,800	$8,158
Missouri	1					8,780	11,849						
Montana	2					(a)	(a)	(a)	(a)				
New Jersey	4	9,200	12,300										
New Mexico	2												
New York	50	19,600	34,913	38,150	13,345	133,000	246,755			2,865,570	208,976	700,000	497,807
Ohio	15	4,200	9,637	458,840	242,074	646,740	706,545	18,880	63,050			952,730	620,217
Oklahoma	4	2,200	2,400	5,300	2,460								
Pennsylvania	97	36,340	66,485	51,390	39,724	97,010	211,041	523,590	583,264	1,688,920	146,334	147,200	102,177
South Dakota	7	500	618	3,430	751			8,210	9,046				
Tennessee	1	(a)	(a)										
Virginia	3	(a)	(a)										
Washington	2					(a)	(a)			(a)	(a)		
West Virginia	4	1,000	750	4,000	3,000			500	630				
Wisconsin	18	11,780	10,656	14,520	17,256	15,060	32,348	116,790	151,843	(a)	(a)	(a)	(a)
Wyoming	1												
Undistributed		8,730	7,689			51,160	75,554	7,560	12,258	542,900	62,759	6,250	8,733
	278	103,140	157,995	624,500	353,047	1,091,300	1,436,515	724,860	881,314	5,371,260	445,541	1,811,980	1,237,092
Average value			1.53		0.57		1.32		1.22		b82.95		0.68

a Included under "Undistributed."

b Per M.

Sandstone sold in the United States in 1922, by States and uses—Continued.

State.	Number of active plants.	Flagging.		Rubble.		Riprap.		Crushed stone.				Other.		Total.	
								Road metal and concrete.		Railroad ballast.				Short tons (approximate).	Value.
		Cubic feet.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.		
Alabama	6			3,630	$1,849	2,620	$6,006							33,750	$41,395
Arizona	2					4,550	2,639							4,550	2,639
Arkansas	2					(a)	(a)	(a)	(a)	(a)	(a)			(a)	(a)
California	12			34,870	48,074	6,760	5,364	401,630	$524,550	12,940	$21,016			456,560	599,815
Colorado	12	2,630	$1,342	3,240	4,849	7,930	9,636	(a)	(a)					32,740	41,695
Connecticut	3													(a)	(a)
Idaho	1													1,240	2,779
Illinois	4							89,380	42,534					91,300	49,993
Iowa	1													(a)	(a)
Kansas	4	830	240	600	500			22,500	40,500					24,070	42,040
Kentucky	7			5,880	4,650	3,810	3,098			70,750	66,750			95,110	200,345
Louisiana	1							570	568	500	500			1,070	1,068
Maryland	1													(a)	(a)
Massachusetts	1			440	396									2,260	56,342
Michigan	3			(a)	(a)	(a)	(a)							(a)	(a)
Minnesota	7			3,010	2,707			66,090	99,744			1,580	$12,672	79,420	159,548
Missouri	1			220	430									920	12,279
Montana	2	(a)	(a)	(a)	(a)							(a)	(a)	(a)	(a)
New Jersey	4					1,000	900							10,200	13,200
New Mexico	2			380	875			2,430	1,748	191,190	110,517			194,000	113,140
New York	50	47,650	43,273			2,170	1,308	203,870	323,540	1,570	2,512			332,160	1,372,429
Ohio	15	559,600	335,692	19,250	17,908	35,660	37,541	44,180	58,451					336,800	2,091,115
Oklahoma	4			3,470	3,950									6,070	8,810
Pennsylvania	97	39,480	25,984	25,400	38,863	4,740	5,740	432,970	603,343	172,230	182,170			1,240,560	2,005,125
South Dakota	7			470	475	5,150	4,775	80,140	113,771	2,000	3,000	3,030	16,287	99,780	148,723
Tennessee	1													(a)	(a)
Virginia	3	(a)	(a)							(a)	(a)			52,870	17,420
Washington	2			(a)	(a)	(a)	(a)							(a)	(a)
West Virginia	4							2,080	2,515	2,320	1,784			6,220	8,679
Wisconsin	18			1,930	1,205	12,990	8,690	73,640	90,532			(a)	(a)	226,480	381,637
Wyoming	1					(a)	(a)	(a)	(a)					(a)	(a)
Undistributed		400	200	2,630	2,128	15,660	13,458	22,800	35,676	52,000	16,800	1,110	3,315	60,000	150,828
	278	650,590	406,731	105,420	128,859	103,040	90,155	1,442,280	1,937,472	505,500	405,049	5,720	32,274	3,388,130	7,521,044
Average value			0.63		1.22		0.96		1.34		0.80		5.64		2.22

a Included under "Undistributed."

BLUESTONE.

The figures of production for bluestone, most of which is quarried in southeastern New York and northeastern Pennsylvania, are included in those of sandstone, but on account of the local importance of this stone they are given separately also.

Almost all the owners of land in this district have small deposits of bluestone on their property and quarry small quantities of it annually, which they sell to agents of large dealers who market the stone. As it is very difficult to obtain the figures of production from these quarrymen, the figures of sales reported by dealers are used by the United States Geological Survey as more nearly representative of the industry. Any reports sent in by individual small quarrymen are valued for the information they furnish relative to the industry, but duplication of figures is avoided.

The stone is used chiefly for flagging, curbing, sills, lintels, steps, and house copings. In recent years much of this stone has been replaced by concrete. In 1922 there was a decided increase over 1921 in all products of bluestone except flagging. The average value for all except "other" products decreased.

Bluestone sold in New York and Pennsylvania in 1921 and 1922.

State.	Building stone.		Curbing.		Flagging.		Other.		Total.	
	Cubic feet.	Value.	Cubic feet.	Value.	Cubic feet.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
1921.										
New York	122,700	$210,930	271,000	$227,665	70,000	$62,515	1,720	$1,376	39,510	$502,486
Pennsylvania	14,000	35,434	115,000	85,637	38,000	35,477	200	762	14,000	157,310
	136,700	246,364	386,000	313,302	108,000	97,992	1,920	2,138	53,510	659,796
Average value		1.80		0.81		0.91		1.11		12.33
1922.										
New York	134,300	247,665	380,000	305,921	46,000	40,663	8,370	10,158	55,660	604,407
Pennsylvania	22,550	12,789	100,500	64,319	39,480	25,984	14,680	19,078	28,600	122,170
	156,850	260,454	480,500	370,240	85,480	66,647	23,050	29,236	84,260	726,577
Average value		1.66		0.77		0.78		1.27		8.62

PRODUCING LOCALITIES.

NORTHEASTERN STATES.

The Northeastern States furnished the "brownstone" that from the middle to the later part of the nineteenth century was so much in demand as a building stone. The sandstone quarries of Massachusetts, Connecticut, and New Jersey still furnish small quantities of this stone as their only product, but in New York and Pennsylvania sandstone quarries other than "brownstone" quarries supply large demands for building (including rough construction), curbing, flagging, and crushed stone. The sandstone (quartzite) quarries of Pennsylvania also supply a large amount of ganister for refractory use.

Massachusetts.—The dark-red and brown sandstone at East Longmeadow, Hampden County, Mass., which was very popular between 1890 and 1900, is now quarried by one company, the Longmeadow Co. (Inc.), operating the Worcester-Brownstone and Kibbe quarries. The stone is known as "Longmeadow Red Sandstone" and "Longmeadow Brownstone." It is sold in rough blocks, as sawed stone, as cut stone, and in small quantities for rubble. In 1922 Sage Hall, at Yale University, New Haven, Conn., was built of this stone, and it was used in the dormitories that were erected at Mount Holyoke College, South Hadley, Mass.

Connecticut.—Brown sandstone (brownstone) is still sold to some extent in Connecticut. In 1922 sandstone for buildings was sold from the quarries of A. J. Ketchim & Co., at Tariffville and Avon, Hartford County; the Brainerd, Shaler & Hall Quarry Co., at Portland, Middlesex County; and Charles W. Blakeslee, at East Haven, New Haven County. The stone is used chiefly at present for trimmings, foundations, and small local buildings and for repair work and additions to buildings for which it was used. At the height of its popularity this stone was shipped to almost every eastern city of any size.

New Jersey.—In 1922 sandstone was produced at two localities in New Jersey. The quarries at Raven Rock, Hunterdon County, were operated by Charles T. Eastburn, of Trenton, and those at Wilburtha were operated by Mr. Eastburn and Gustave De Grave. The stone is used for rough construction work only. It is medium grained and brown or gray. At one time the brown stone was used extensively for residences and as trimming for different classes of buildings. A small quantity of sandstone is also quarried annually at Kingston, Somerset County, by the Delaware & Raritan Canal Co. for riprap and repair work. One of the first "brownstone" quarries opened was near Paterson, N. J.

New York.—Outside of "bluestone" very little sandstone for building stone is quarried in New York. The Danforth Pink Sandstone quarry, at Burke, Franklin County, operated by Crippen Bros., annually produces stone for sills, lintels, mantels, fireplaces, flagging, etc. Sandstone for rough construction work is sold by James Hallinan, at Little Falls, Herkimer County; C. B. Whitmore & Co., at Lockport, Niagara County; and J. W. Dawes, at Clinton, Oneida County. All this stone is used locally.

The sandstone quarried in Orleans County is sometimes sold in small quantities as building stone, but the greater part of it is sold for flagging, paving, and curbing. The producing companies in 1922 were as follows:

Di Laura Stone Co., Chadwick quarry, Albion.
Monacelli Stone Co., Brady quarry, Albion.
Thomas Monacelli, Goodrich quarry, Albion.
F. H. Rhodey, Albion; spalls crushed at Reed, Allen & Reed quarry.
M. A. Ryan Sandstone Quarries; Albion, Holley, and Hulburton.
Aufidena Stone Co., Cornell quarry, Fancher.
James L. Clark, Fancher.
Balmforth Bros., Holley.
Holley Medina Stone Co., Keys quarry, Holley.
Thomas Vincelli, Squires quarry, Holley.
Moore & Wait, Hulburton.
W. J. Gallagher, Medina.

Several of these firms operated quarries leased from the Orleans County Quarry Co., which no longer operates quarries.

At one time a considerable quantity of red sandstone, known as "Potsdam Red Sandstone," was quarried near Potsdam, but none of the quarries are now in operation. In 1922 sandstone was quarried at Schenectady, Schenectady County, by the Webster & Springer Co., for local construction work, trimmings, foundations, and floors and crushed stone for street work, and by the Schenectady Railway Co. (Kellums quarry) for concrete and ballast. Near Gilboa, Schoharie County, gray sandstone was quarried in 1921 and 1922 for the Board of Water Supply of New York City, for the facing and construction of the Gilboa dam of the Catskill water system of New York. This material was obtained from the Riverside quarry and the Stevens Mountain quarry. Near Ithaca, Tompkins County, Cornell University at times quarries sandstone for new buildings. In 1922 the New Chemistry Building and Boldt Hall were built of stone from the Slight Farm and University Farm quarries.

The United States Geological Survey has no record of all the quarry operators in New York producing bluestone (dark bluish-gray sandstone), as most of this stone is purchased by dealers from owners of small deposits. It is used for trimmings of houses, sills, lintels, copings, steps, foundations, stair treads, and landings, but seldom for entire buildings. This material is used chiefly, however, for flagstones, curbing, and cross walks. The following are the principal dealers and quarrymen active in 1922:

Broome County:
Deposit: D. G. Underwood; quarry operator and dealer.
Chenango County:
Norwich: Clarke Conroy & Co.; quarry operator.
Oxford:
Graham & Aylesworth; quarry operator.
McNierney Bros.; dealers.
Delaware County:
Cadosia: C. D. Mason; quarry operator.
East Branch:
H. A. Schneider; dealer.
William P. Schneider; quarry operator and dealer.
Horton: Johnston & Rhodes Bluestone Co.; quarry operator and dealer.
Steuben County:
Corning: Corning Stone Corporation; crushed stone.
Sullivan County:
Long Eddy: Kenney Bros.; quarry operators and dealers.
Ulster County:
Kingston: Herbert Shaw; dealer.
Saugerties:
Catskill Mountain Bluestone & Piling Corporation; dealer.
John Maxwell Sons; dealers.
Wyoming County:
Ambluco and Rock Glen: American Blue Stone Co. (address, Portageville); "Ambluco Stone"; quarry operator.
Portageville: Portageville Bluestone Co.; quarry operator.
General: Erie Bluestone Association, 159 West 33d Street, New York City; dealer.

Pennsylvania.—The principal quarries in Pennsylvania that furnish sandstone for building material other than rubble and rough construction work are those of the Hummelstown Brownstone Co., at Waltonville, Dauphin County. The stone from these quarries is sold as rough dimension stone for the better class of buildings, as sawed and cut stone for exterior use and trimming, and in rough

blocks for foundations, walls, etc., and crushed stone. The "Hummelstown Brownstone," as it is known to the trade, has its principal market at present in Philadelphia, Harrisburg, and near-by cities and towns. At the time of the popularity of brownstone residences it was shipped in considerable quantities to many eastern cities. It is dark brown with a slight purplish tinge and is fine grained.

In 1922 stone was quarried at Ellwood City, Lawrence County, by the Ellwood Stone Co. and the Kings Creek Stone Co., of New Cumberland, W. Va., for the construction of the Sixteenth Street bridge over Allegheny River at Pittsburgh and for the Bull Creek bridge at Tarentum. This is a buff medium-grained stone and has been sold mostly in Pennsylvania. It is sold also for curbing and rubble. A fine-grained reddish-brown sandstone quarried at Mount Gretna, Lebanon County, by the Mount Gretna Brownstone Co., has for many years furnished building stone for trimmings and facing of buildings in many cities of southeastern Pennsylvania, but the quarry was idle in 1922. A reddish-brown fine-grained sandstone, sold mostly for local work, is quarried in Luzerne County, near Wilkes-Barre, by Geick & Traill (Laurel Run quarry), and near White Haven by the White Haven Quarry Co. The principal products of the White Haven quarry at present, however, are paving blocks and crushed stone.

A considerable amount of sandstone of all classes quarried in Pennsylvania is sold as dimension stone for rough construction work, such as foundations, walls, and rough bridge work, and is used as rubble and random ashlar in the construction of moderate to high priced houses. A list of producers of this material and of paving blocks and crushed stone is given below.

Allegheny County:
  Pittsburgh:
    R. T. Lambert Co.; blue fine-grained stone; rubble.
    Weinman Bros.; blue stone, used in manufacture of concrete blocks.
  Rosedale: P. Navarro & Son (address, Pittsburgh); rubble, riprap.
Armstrong County:
  Dayton: B. R. Marshall; rough construction.
Beaver County:
  New Brighton: A. F. Smith Co.; rough construction.
Berks County:
  Temple: Temple Fire Clay Co.; crushed stone.
Blair County:
  Altoona: J. W. Stine; rough construction.
Bucks County:
  Danboro: A. H. Fell, Hillside quarry; rough construction.
  Janney and Lumberville: Charles T. Eastburn (address, Trenton, N. J.); rough construction, riprap.
  Langhorne:
    Jos. H. Leinington; rough construction.
    David V. Ridge estate, Sugar Loaf Farm quarry; rough construction.
  Richlandtown: L. M. Weaver's Sons; "blue rock"; crushed stone.
  Telford: H. C. Derstine; medium-grained "blue stone"; rough construction, crushed stone.
Butler County:
  Butler: George Schaffner; rough construction.
Carbon County:
  Tannery: White Haven Stone Products Co. (Inc.) (address, Hazelton); paving blocks.
Clearfield County:
  Clearfield: A. Tate, Ivry quarry; rough construction.
  Dubois: Johnson & Kearns; rough construction, crushed stone.
Crawford County:
  Meadville: Karl A. Miller; rough construction.

Dauphin County:
Harrisburg: Rockville Quarry Co.; crushed stone.
Delaware County:
Chester: Alex. Miller; rough construction.
Fayette County:
Connellsville: Casparis Stone Co. (address, Columbus, Ohio); crushed stone, railroad ballast.
Greene County:
Waynesburg:
Brick & Stone Co., Smith Creek quarry; building, rubble, crushed stone.
George Chapman, Hook quarry; rough construction, riprap.
Huntingdon County:
Water Street:
American Lime & Stone Co. (address, Bellefonte); railroad ballast.
Water Street Trap Rock Co.; crushed stone.
Jefferson County:
Punxsutawney: Adams & Errigo; rough construction.
Lackawanna County:
Scranton:
Rock Bros.; rough construction.
Peter Stipp & Sons; medium-grained blue-gray stone; rubble, crushed stone.
Lancaster County:
Columbia: Chicquies Mining & Manufacturing Co.; crushed stone.
Lawrence County:
Neshannock Falls: Martin Brick Co. (address, Pittsburgh), Neshannock quarries; rough construction.
Luzerne County:
Pond Hill: Pond Hill Crushed Stone Co. (address, Wilkes-Barre); crushed stone.
White Haven:
General Crushed Stone Co. (address, Easton); rough construction, curbing, crushed stone for concrete, road metal, railroad ballast.
J. U. Kurtz (address, Berwick), Cooper quarry; paving blocks.
White Haven Quarry Co. (Ltd.); rough construction, paving blocks, curbing, crushed stone.
Wilkes-Barre:
General Crushed Stone Co. (address, Easton), Hendlers quarry; crushed stone for concrete, road metal, ballast.
Kelly Run Crushed Stone Co.; rough construction, crushed stone.
Lycoming County:
Muncy: Susquehanna Stone Co. (address, Williamsport), Miller Siding quarry; crushed stone.
Picture Rocks: George West; rough construction.
Williamsport: George & Arden Mayer, Guise quarry; rough construction.
Monroe County:
Analomink: Delaware, Lackawanna & Western Railroad Co. (address, New York City); railroad ballast.
Montgomery County:
Ambler: Lindenwold Farms & Quarries; rough construction, crushed stone.
Northumberland County:
Dalmatia: Susquehanna Stone Co. (address, Williamsport); crushed stone.
Philadelphia County:
Chestnut Hill: Lorenzon Bros. (address, Philadelphia); rough construction.
Somerset County:
Somerfield: State Highway Commission (address, Harrisburg), J. P. McMullen quarry; road work.
Westmoreland County:
Armbrust: J. W. Hudgkin; rubble.
Belle Vernon: Rostraver Township Supervisors; road work.
Blairsville: Booth & Flinn (address, Pittsburgh), McSpadden quarry; paving blocks, crushed stone.
Gray: Thomas Cronin Co. (address, Pittsburgh), Jones quarry; paving blocks.
Jeannette: Jeannette Brick & Stone Co.; rough construction, riprap.
Ligonier: Booth & Flinn (address, Pittsburgh), Childs quarry; paving blocks, crushed stone.

Ganister, a fine-grained, nearly white quartzite, is crushed and used in the manufacture of silica brick and ferrosilicon and for furnace and converter lining. Many of the brick manufacturers quarry their own stone. The producers of this refractory material in 1922 were as follows:

Bedford County:
- Buffalo Mills: James Kelly, Ore Hill quarry; furnace or converter lining.
- Madley: Leap Ganister Rock Co.; silica brick, furnace or converter lining.
- Wolfsburg: E. R. Baldrige & Co. (Inc.) (address, Hollidaysburg); furnace or converter lining.

Blair County:
- Claysburg: General Refractories Co.; silica brick, ferrosilicon.
- Flowing Spring: J. L. Hartman Co. (address, Hollidaysburg), Loudon quarry; silica brick.
- McKee: Kier Fire Brick Co. (address, Pittsburgh), Brookes Mills quarry; silica brick, furnace or converter lining.
- Sproul: J. L. Hartman Co. (address, Hollidaysburg), Sarah Furnace quarry; silica brick.

Center County:
- Port Matilda: Superior Silica Brick Co. (address, Altoona); silica brick, ferrosilicon.

Fayette County:
- Dunbar: United Refractories Co., Ferguson quarry; silica brick.
- Layton: Kier Fire Brick Co. (address, Pittsburgh), Childs quarry; silica brick.
- Uniontown: A. M. Springer, Cool Spring quarry; silica brick.

Huntingdon County:
- Alexandria: Federal Refractories Co. (address, Cleveland, Ohio); silica brick.
- Barree: E. R. Baldrige & Co. (Inc.) (address, Hollidaysburg); furnace or converter lining.
- Mount Union and Water Street: Harbison-Walker Refractories Co. (address, Pittsburgh); silica brick.
- Neelyton: General Refractories Co. (address, Philadelphia), Stanton quarry; silica brick.
- Three Springs: United Refractories Corporation (address, Mount Union); silica brick.

Indiana County:
- Robinson: Garfield Fire Clay Co., Garfield quarry; silica brick.

Lackawanna County:
- Scranton: L. J. Bour Refractories Co.; manufacture of refractory cement.

Lancaster County:
- Columbia: Chicquies Mining & Manufacturing Co.; ferrosilicon.
- Narvon: Harbison-Walker Refractories Co. (address, Pittsburgh); silica brick.

Lawrence County:
- Newcastle: National Stone Co.; furnace or converter lining.

Mercer County:
- Mercer: National Stone Co. (address, Newcastle); furnace or converter lining.

Mifflin County:
- Hawstone: Haw Refractories Co. (address, Johnstown); silica brick.

Montgomery County:
- Spring Mills: Henry Mauer & Son (address, Philadelphia); silica brick.

Besides ganister, mica schist is quarried in Montgomery County for refractory use, such as the lining of furnaces and kilns. The statistics of the material are placed with "miscellaneous" stone, but the names of operators are given here:

- Edge Hill Silica Rock Co. (address, New Brunswick, N. J.), Edge Hill.
- Edge Hill Stone & Construction Co. (Inc.) (address, North Glenside), Edge Hill.
- Kenyon Bros., Edge Hill.
- J. W. Paxon Co. (address, Philadelphia), Glenside.

The following firms produce mica schist for building stone (rough construction):

Jno. W. Hibberd. Media, Delaware County.
S. L. Clayton, Edge Hill, Montgomery County.
Edge Hill Stone & Construction Co., Edge Hill, Montgomery County.
J. F. T. Comly (address, Edge Hill), Chestnut Hill, Philadelphia.

As in New York, a variety of fine-grained sandstone, called bluestone, is quarried in Pennsylvania by many owners of small quarries and sold through dealers for trimmings of buildings and for curbstone and flagstone. The dealers and the larger quarrymen who sell directly to the market are listed below. The dealers are indicated; the others are quarry operators.

Bradford County:
Standing Stone: Horace Ruger (address, Laceyville), Durell quarry (also dealer); curbing, flagging.
Towanda: J. B. Neiley; flagging.
Lycoming County:
Jersey Mills: Peter Barr & Sons (address, Shamokin); curbing, flagging.
Waterville: F. F. Fuller.
Pike County:
Dingmans Ferry: J. Van Sant Hood; flagging.
Kimbles: Olivo Sartori, Long Swamp quarry; curbing.
Lackawaxen: Smith & Beisel; curbing, flagging.
Pond Eddy: A. H. Woodward Co. (address, Newark, N. J.), Bear Swamp quarry (also dealer); curbing, flagging.
Susquehanna County:
Alford:
Alford Bluestone Co.; building, curbing, flagging.
Charles Craft; flagging.
Lanesboro: F. T. Winters; crushed stone.
Montrose: Daugherty & Winans (address, R. D. No. 3, Meshoppen), Jones quarry; curbing, flagging.
Stevens Point: Richard Bailey; curbing.
Wayne County:
Honesdale: J. H. Bowen; curbing, flagging.
Stevens Point (near):
Bailey Bros., Putnam quarry; curbing.
A. J. Spear; curbing, flagging.
Wyoming County:
Meshoppen: B. Ridgway & Son (address, Philadelphia); "Ridgway Flagstone" (also dealer); buildings, curbing, flagging.
Nicholson: Franklin Stone Co.; curbstone.
Wyoming: J. B. D. Stone Co. (Inc.); crushed stone.
General: John Maxwell's Sons (dealers; address, Philadelphia); curbing.

Sandstone (including quartzite and mica schist) sold in Pennsylvania in 1922.

	Quantity.	Value.
Rough building (architectural)....cubic feet..	51,390	$39,724
Approximate equivalent in short tons....	4,220	.....
Dressed (sawed and cut) building....cubic feet..	97,010	211,041
Approximate equivalent in short tons....	7,950	.....
Rough construction....short tons..	68,340	124,445
Rubble....do....	25,400	38,863
Crushed stone....do....	605,200	785,513
Refractory (ganister and mica schist)....do....	554,260	665,935
Paving blocks....number..	1,688,920	146,334
Approximate equivalent in short tons....	17,730	.....
Curbing....linear feet..	196,350	102,177
Approximate equivalent in short tons....	12,130	.....
Flagging....square feet..	236,880	25,984
Approximate equivalent in short tons....	3,260	.....
Riprap....short tons..	4,740	5,740
Approximate total in short tons....	1,303,230	2,145,756

SOUTHEASTERN STATES.

The quarries at Kingwood and Kings Creek, W. Va., and at Wildie, Farmers, and Bluestone, Ky., furnish the only building stone of any importance at present quarried in the Southeastern States. Stone is also quarried for riprap, rubble, rough construction, crushed stone, etc.

Virginia.—The Peak Creek Sandstone Co., of Pulaski, Pulaski County, Va., produces a sandstone for local building work in that State. The George Washington Stone Corporation, of Alexandria, has recently made plans for the reopening of the old Aquia Creek quarries near Fredericksburg, Stafford County, and proposes to erect a plant at Alexandria for sawing and finishing the stone. These quarries, about 80 years ago, furnished the stone for the construction of the United States Capitol, White House, Patent Office, and many other prominent buildings. The stone is light gray, streaked or clouded with various shades of buff, yellow, and red that are at present popular with architects. Sandstone for railroad ballast is produced at Basic, Augusta County, by the Mathew Curtis Co. (Inc.), of Clifton Forge.

West Virginia.—The Kingwood Stone Co., of Kingwood, Preston County, W. Va., furnished a medium-grained cream-colored stone for building in 1922. This stone has been used for exterior work in New York City and Washington, for interior work in public buildings in Jersey City, N. J., and for residences in Michigan, Pennsylvania, and West Virginia. The Kings Creek Quarry Co., of Kings Creek, Hancock County, quarries stone for local use as rubble, curbing, and riprap, but the quarry was idle in 1922. The Berkeley Glass Sand Co. sells crushed sandstone for furnace or converter lining, concrete work, and stucco as a by-product of its silica-sand business at Berkeley Springs, Morgan County. The Holswade Stone Co. crushes a small quantity of sandstone from quarries at Spencer, Roane County. Other sandstone is quarried in West Virginia and manufactured into grindstones and pulpstones or crushed for glass and other sand.

Maryland.—The only sandstone reported from Maryland in 1922 was used for furnace or converter lining and was quarried at Cumberland, Allegany County, by the Bessemer Loam-Sand Co., of Newcastle, Pa.

Kentucky.—Sandstone for building is quarried at two localities in Kentucky. The deposit at Wildie, Rockcastle County, is worked by the Kentucky Freestone Co., of Cincinnati, Ohio. The stone is used mostly for trimmings, sills, copings, and other small parts of buildings. In Rowan County there are three active companies—the Blue Grass Quarries Co. and Kentucky Bluestone Co., at Bluestone, and the Rowan County Freestone Co., at Farmers. The greater part of sandstone from this county is sold as sawed stone, but some of it is cut. The principal market for it is in Kentucky; it is also used largely in Ohio, especially in Cincinnati, and has been shipped to New York, North Carolina, Texas, West Virginia, and other States and Canada. The stone is very fine grained and can be rubbed to a good finish but not polished. In this form it finds use in interior work, especially for mantels. It is also used for burial vaults and is sold as riprap, rubble, and crushed stone.

Occasionally small quantities of building stone are quarried elsewhere in Kentucky for local use but not from regular quarries. The available figures for such stone are included in the following table:

Building sandstone (rough and dressed) sold from Kentucky, 1916–1922.

Year.	Cubic feet.	Value.	Year.	Cubic feet.	Value.
1916	121,000	$65,766	1920	97,430	$101,718
1917	115,000	53,276	1921	88,940	86,244
1918	51,443	20,918	1922	142,260	120,050
1919	120,925	84,312			

Sandstone for local road work, ballast, and some rough construction was quarried in 1922 at Harlan, Harlan County; by the Cumberland & Manchester Railroad Co. at Barboursville, Knox County; and at Williamsburg, Whitley County.

Tennessee.—The only sandstone quarry operated in Tennessee is on the property of the University of the South at Sewanee, Franklin County. The stone is used for construction.

Alabama.—Sandstone reported as sold for building in Alabama is quarried at Hartsells, Morgan County, by W. W. Brooks. The stone is used in the form of hand-dressed ashlar for facing and trimming of buildings and for foundations. It is yellowish in color. The market is chiefly local, although some stone has been shipped outside the State, notably to Florida. Sandstone from the quarry belonging to the Alabama Insane Hospital at Tuscaloosa, Tuscaloosa County, is used by the Engineer Corps of the United States Army for riprap and rubble along Black Warrior River. Sandstone for the manufacture of silica brick is quarried at Oxford, Calhoun County, and Rock River, Cherokee County.

EAST CENTRAL STATES.

Ohio and Wisconsin are the largest producers of sandstone in the East Central States. Ohio is the largest producer in the United States of sandstone for architectural building purposes, and the greater part of such stone comes from Lorain and Scioto counties, although appreciable amounts are produced in Carroll, Cuyahoga, and Holmes counties. In total production of sandstone Ohio ranks third, being exceeded by Pennsylvania and California.

Ohio.—The sandstones of northern Ohio are mostly blue, gray, buff, and variegated and fine to medium grained. The buff and variegated stones are used in exterior building and trimmings and are well adapted to interior work for office buildings, churches, and residences. The stone from Scioto County is bluish gray and very fine grained and is used largely for burial vaults and abrasive stones. The sandstone of Ohio is shipped for building to all the Middle and North Central States and has had a considerable market in the East, especially in New York City. It is sold as stone for rough construction work, rough building blocks, and sawed and cut stone. Much of the stone is cut after it leaves the hands of the quarrymen. The following table shows the condition in which the building stone was sold by the quarrymen in 1920–1922:

Building stone sold in Ohio, 1920–1922.

Kind.	1920		1921		1922	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Rough construction.....short tons..	390	$1,406	3,590	$5,318	4,200	$9,637
Rough architectural.....cubic feet..	497,200	332,246	424,760	218,582	458,840	242,074
Sawed stone.....do....	355,770	369,041	541,760	539,544	637,000	646,815
Cut stone.....do....			6,660	15,806	9,740	59,730
Approximate total.....short tons..	70,580	702,693	81,590	779,250	94,830	958,256

Many of the quarries also furnish stone for grindstones, scythestones, pulpstones, lathe stones, holystones, rubbing stones, and other abrasive stones and for curbing, flagging, riprap, rubble, and crushed stone; refractory stone for furnace lining and acid tanks; and stone ground and used as fire and furnace sand. The Structural Stone Co., of Hubbard, Ohio, uses the product of the McDermott and South Euclid quarries for the manufacture of laundry trays and sinks.

The operators of quarries in 1922 were as follows:

Carroll County:
  Sherrodsville: Buff Mountain Quarries Co.; "Buff Mountain stone."
Columbiana County:
  Lisbon: Smallwood-Low Stone Co.
Cuyahoga County:
  Berea:
    Cleveland Stone Co. (address, Cleveland).
    Middleburg Stone Co. (address, Elyria).
  South Euclid: Green Road Stone & Supply Co.
Holmes County:
  Glenmont: Briar Hill Stone Co.
Jefferson County:
  Empire: Smallwood Stone Co. (address, Steubenville).
Lorain County:
  Amherst:
    Ohio Quarries Co. (address, Cleveland); "Buckeye Gray."
    Cleveland Stone Co. (address, Cleveland); "Gray Canyon" and "Ohio Buff."
Mahoning County:
  Youngstown: Haselton Sand & Stone Co.
Scioto County:
  McDermott:
    McDermott Stone Co.
    Waller Bros. Stone Co.
Washington County:
  Marietta: Marietta Stone Co.

Illinois.—No sandstone of any importance for building stone is produced in Illinois. A small amount was quarried in 1922 from the Schumacher quarry, near Red Bud, Randolph County, by William Melly, and used for rough construction. At Ashton, Lee County, a small crushing plant was operated by Ashton Township. At Elco, Alexander County, the Western Fire Brick Co. quarried stone for converter lining, and at Tamms the Novaculite Paving Co. operated the Bryden quarry for stone for silica brick and road metal.

Michigan.—A small quantity of sandstone for buildings and rubble is at times quarried at Grindstone City, Huron County, Mich., by the Cleveland Stone Co., of Cleveland Ohio, but this sandstone

is used chiefly for grindstones and pulpstones. In 1922 stone for rough construction was taken from the property of the Chapin Mining Co., at Iron Mountain, Dickinson County, by Anton Miench, and red sandstone for rubble was quarried by Holfetz & Eisele at the same place. A fine-grained gray sandstone was at one time quarried at Jacobsville, Houghton County, and used for building stone. The light-red sandstone at Portage Entry and the brown "raindrop" sandstone at Marquette were formerly used extensively for local buildings and were also shipped to distant points. The Marquette quarry has not been operated since 1911, however, and the Portage Entry quarry, after supplying a small local demand for several years, was abandoned in 1918.

Wisconsin.—In 1921 and 1922 the Port Wing Brownstone Co. produced building stone from the sandstone quarries at Port Wing, Bayfield County, Wis., which had been idle for several years. This is a coarse-grained reddish-brown stone. It has been used in many public and private buildings in Illinois, Iowa, Minnesota, Nebraska, North Dakota, Wisconsin, and Canada.

A center of considerable importance in the building-sandstone industry of Wisconsin is Dunn County. The companies that operated there in 1922 are as follows:

Colfax Stone Co. (address, Chippewa Falls), quarry at Colfax; produces a fine-grained cream-colored stone that has been used for the construction of residences, schools, churches, banks, and other buildings in Wisconsin, Iowa, and South Dakota. In 1922 it was used for exterior and interior work in the Luther Memorial Church at Madison.

H. Walter Stone Co. (address, Brownsville), Dunnville; produces a fine-grained buff sandstone used for building, riprap, rubble, and crushed stone. It has been used for the facing and trimming of many school buildings, churches, hotels, residences, and banks, chiefly in Wisconsin, but also in Iowa and Montana. In 1922 it was used in the construction of schools, churches, and public buildings in Iowa and Wisconsin.

William H. Ulmer Co. (address, St. Paul, Minn.), Dunnville; produces a fine-grained cream-colored stone, sold mostly in rough blocks for buildings but also for riprap and rubble. It has been used for State and Federal buildings in Wisconsin, North Dakota, Iowa, Minnesota (St. Paul, especially), and South Dakota and has also been sold in the eastern markets.

The stone from Dunn County is marketed in the East as "Dunnville Stone." It is soft and is easily worked when first quarried but hardens on exposure. It is effective in carved and cut work, an example being the reredos of St. Thomas's Church, New York City, stone for which was furnished by the William H. Ulmer Co.

Stone produced in Dunn County, Wis., 1917–1922.

Year.	Building stone, rough and dressed.		Other.[a]		Total.	
	Cubic feet.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
1917	23,600	$21,970	7,570	$3,808	9,500	$25,778
1918	[b] 18,830	[b] 10,252	12,670	5,663	14,200	15,915
1919	17,680	25,720	5,650	6,274	7,080	31,994
1920	18,060	43,867	7,140	4,971	8,600	48,838
1921	26,640	42,536	3,680	2,303	5,840	44,839
1922	17,680	33,570	8,232	4,529	9,660	38,099

[a] Includes stone sold for riprap, rubble, and crushed stone. [b] Chiefly rough stone.

Other quarries in Wisconsin were operated in 1922 as follows:

Dane County:
Madison: E. F. Paunack; medium-grained buff sandstone; buildings, rubble.
Portage County:
Stevens Point: P. J. O'Connor; coarse-grained brown stone; paving blocks, rubble, riprap.
Sauk County. Besides those named several quarries were operated by the State for crushed stone for road work.
Ableman:
General Refractories Co. (address, Philadelphia, Pa.), LaRue quarry; quartzite; silica brick, crushed stone.
White Oak Quarry Co. (address, Milwaukee); white to pinkish fine-grained light-pink quartzite; rough construction, dressed building, paving blocks, curbing, riprap.
Wisconsin Granite Co. (address, Chicago); fine-grained light-pink quartzite; rough construction, furnace or converter lining, ferrosilicon, crushed stone for concrete, stucco.
Baraboo:
American Refractories Co. (address, Pittsburgh, Pa.), Devils Lake quarry; blue-gray coarse-grained quartzite; silica brick, furnace or converter lining.
Baraboo City; reddish-purple quartzite; crushed stone.
North Freedom: Harbison-Walker Mining Co. (address, Pittsburgh, Pa.); quartzite; silica brick.
Trempealeau County:
Arcadia: J. J. Schneider; foundations.
Wood County:
Wisconsin Rapids:
Brown Bros. (address, Pittsville), Richfield quarry; crushed stone.
Wisconsin Granite Co. (address, Chicago); rough construction, paving blocks.

WEST CENTRAL STATES.

Minnesota and South Dakota are the largest producers among the West Central States. Their output includes building stone, stone for rough construction, ganister, and crushed stone for road metal, concrete, stucco, ballast, etc.

Minnesota.—The Kettle River quarries, at Sandstone, Pine County, Minn., operated by the Sandstone Quarries Co., of Minneapolis, furnish most of the sandstone quarried in Minnesota for building, although the chief output of the quarries is paving blocks. This stone, which is known as "Kettle River Sandstone," is even grained and ranges from light pink to yellow and brownish red. It has been used in many parts of the United States and has been shipped to Canada. It is used for exterior and interior building, flagging, rubble, riprap, furnace or converter lining, and crushed stone. In 1922 stone from these quarries was used in the construction of the Methodist Episcopal Temple at Lansing, Mich.

The Jasper Stone Co., near Jasper, Rock County, furnished building stone in 1922 for a high school at Sioux Falls, S. Dak., but the output of this company is used chiefly for crushed stone, tube-mill lining, grinding pebbles, and stucco. Sandstone (quartzite) for crushed stone was produced in 1922 by the Voss Stone Co. in Nicollet County near New Ulm, Brown County; the New Ulm Stone Co. at New Ulm, Brown County; Hanlon & Okes and the Polk County Grinding Co., of Dresser Junction, Wis., at Pipestone, Pipestone County; and the Quartzite Quarries (Inc.) at Luverne, Rock County. The material crushed by the Polk County Grinding Co. was used for stucco and for granules in the manufacture of prepared roofing.

South Dakota.—Little of the sandstone (quartzite) quarried in South Dakota is at present used for buildings. At one time stone from the quarries at East Sioux Falls, Hot Springs, and Spencer was used for many buildings both locally and throughout the State and in Iowa, Nebraska and Wyoming. Paving blocks were also made and shipped, but at present crushed stone represents the chief product. The principal producing companies in 1922, with their products, are given below.

McCook County:
Spencer: Spencer Quarry Co.; fine-grained red quartzite; crushed stone.
Minnehaha County:
Dell Rapids:
Simpson Stone Co.; medium-grained pinkish quartzite; ashlar, rubble, riprap, crushed stone.
Superior Construction Co.; pink quartzite; converter or furnace lining, concrete, and stucco.
East Sioux Falls:
W. V. Lowe Granite Co. (also at Rowena); rough construction, riprap.
National Crushed Stone Co.; fine-grained pink quartzite; crushed stone, railroad ballast.
Sioux Falls: Wisconsin Granite Co. (address, Chicago); light-red quartzite; furnace or converter lining, ferrosilicon, rubble, riprap, crushed stone, stucco.

Iowa.—H. D. Kregel operated a small local quarry in 1922 for foundation stone at Garnavillo, Clayton County, Iowa.

Missouri.—The only sandstone quarry operated in Missouri in 1922 was that of Benjamin Pickel, at Warrensburg, Johnson County. This quarry, which had been idle since 1918, was opened to furnish stone for the Auditorium Building, Central States Teachers College, Warrensburg. The stone is a fine-grained bluish-gray sandstone and has been used throughout the Central States.

The Carroll County Sandstone Co., with quarry at Miami Station, which has supplied a large amount of building stone to cities and towns in Missouri and neighboring States, was idle in 1922.

Kansas.—Small quantities of sandstone are quarried annually in Kansas for foundations, flagging, and rubble. The operators of quarries in 1922 were R. S. Gilfillan & Son (Bandera quarry), Redfield, Bourbon County; A. J. Slates, Chautauqua, Chautauqua County; and the Independence Brick Co., Independence, Montgomery County. The Lincoln Crushed Stone Co., Lincoln, Lincoln County, opened a quartzite quarry in 1922 for crushed stone.

SOUTH CENTRAL STATES.

The output of sandstone in the South Central States is negligible. For the first time a production is reported from Louisiana.

Arkansas.—The only sandstone quarry reported in operation in Arkansas in 1922 was the Bee Rock quarry, at Searcy, White County. This quarry is owned and operated by the United States Government for riprap.

Louisiana.—The Peason Rock Co. (Inc.), of Shreveport, La., opened a sandstone quarry in 1921–22 for crushed stone for concrete and railroad ballast at Florien, Sabine County. This is the only sandstone quarry operated in Louisiana.

Oklahoma.—Sandstone quarried for construction in Oklahoma is reported in small quantities by Samuel Keaton, D. H. Neely, and John Parks at Muskogee, Muskogee County. It is used for sills,

water tables, rubble, ashlar, and foundations. A quarry at Cushing, Payne County, was operated for rubble in 1922 by Hopkins & Co.

ROCKY MOUNTAIN STATES.

Montana.—A medium-grained buff sandstone quarried at Great Falls, Cascade County, Mont., by Grover & Leuchars, is the only sandstone at present quarried for use as building stone in Montana. It is used locally and throughout the State for facing, trimmings, foundations, and rubble work and occasionally for monuments. Sandstone for the manufacture of silica brick was quarried in 1922 by Daniel A. Graham, at Anaconda, Deer Lodge County.

Wyoming.—The only sandstone quarries in Wyoming reported as active in 1922 were those of the Union Pacific Railroad Co. at Rawlins, Carbon County, which were operated for riprap and crushed stone.

Colorado.—The greater part of the sandstone at present quarried for buildings in Colorado comes from the quarries of the Turkey Creek Stone, Clay & Gypsum Co. (address, Pueblo) at Stone City, Pueblo County. This is a fine-grained light-gray to white stone with fine dark wavy lines running through it. It has been shipped outside of the State, but its largest market is in Denver. It is sold for foundations, trimmings, and exterior work and for ornamental entrances of buildings and theater lobbies. Sandstone for building was also quarried at Lyons, Boulder County, by J. C. Brodie, operating the St. Vrain Red Sandstone quarries. The Noland quarries, operated by Axel Berguist, were idle in 1922. They yield a medium-grained red stone which has been used chiefly for paving, curbing, flagging, and crushed stone. It is nearly all used locally but has been shipped outside of the State (to Nebraska in 1921). Sandstone for building has also been quarried at the Kenmuir Red Sandstone quarry, at Colorado City, El Paso County, by the Greenlee Stone & Building Co., of Denver, Colo. The only demand for the stone at present is for use in alterations or repairs in buildings for which the stone was first used. The quarry was idle in 1922.

A small amount of light-gray fine to medium grained sandstone was quarried at Durango, La Plata County, for building and rubble, by P. F. Cummings and by David Ramsey. This stone was used in a school building at Mancos, Montezuma County, where a small sandstone quarry was also operated. Stone was also crushed at Durango by the La Plata Transfer Co.

At Fort Collins, Larimer County, the Slab Gate quarries were operated in 1922 by Henry Josefson, and the Dixon Canyon quarries by Swan Johnson. There is little demand for the stone, and the quarries are practically idle. The product is used for rough building, flagging, and rubble. This stone at one time was shipped to Denver and other places in Colorado, as well as to Wyoming and Kansas. In 1922 it was used in the Union Pacific Railroad station at Cheyenne, Wyo. At Montrose, Montrose County, the Silver Ledge quarry has been operated by Sanford Heath and the Sunny Slope quarry by Harry Jones for local building and foundation work. The stone is medium grained and ranges from white to light gray and pinkish gray. In 1922 the Silver Ledge quarry was idle, but stone

from the Sunny Slope quarry was used in building the Montrose County courthouse, at Montrose.

Sandstone for the manufacture of silica brick and for converter lining is also quarried in Colorado. Stone was furnished for this purpose in 1922 by the Colorado State Penitentiary, Diamond Fire Brick Co., and S. Vernon St. John (Burnito quarry), Canon City, Fremont County; the Standard Fire Brick Co., Parkdale, Fremont County; and the Turkey Creek Stone, Clay & Gypsum Co., Stone City, Pueblo County.

New Mexico.—A small quantity of sandstone is quarried annually at the Rohr quarry, Raton, Colfax County, N. Mex., by Isaac Lundberg, and sold locally for rubble or rough construction. At the Government quarry near Zuni, McKinley County, some sandstone is quarried for the walls of the houses of the Zuni Indians. The stone is quarried by those who wish to use it. Quartzite for railroad ballast and railroad concrete work was quarried in 1922 at the Sais quarry, Scholle, Torrance County.

Arizona.—A fine-grained red-brown sandstone quarried at Flagstaff, Coconino County, Ariz., was at one time used extensively for buildings. At present the quarry is owned by the estate of Daniel Halladay and is operated only to supply stone for additions, repairs, or remodeling of buildings in which the stone has been previously used. In 1921 stone was furnished to the contractors who repaired the post office building at Sacramento, Calif. This quarry was idle in 1922.

Utah.—Red banded sandstone for local buildings has been quarried in Emigration Canyon, near Salt Lake City, Utah, but the quarries are now abandoned.

Idaho.—The Boise Stone Co., Boise, Idaho, operated the only sandstone quarry in the State in 1922. The quarries of this company are on Table Rock, about 2 miles from Boise, Ada County. The stone is medium grained and light-buff in color and is sold as "Boise Sandstone." It has been used for most of the State, Federal, and public buildings in Boise and other parts of Idaho and has been shipped to Colorado, Oregon, and Washington. In 1922 the stone was used for exterior work in the Auditorium Building at Colorado Springs, Colo. The Penitentiary quarry, also on Table Rock, has furnished the stone for the numerous buildings of the Idaho State Penitentiary and is operated intermittently by the labor of the inmates at such times as the stone is needed. The material is a fine-grained gray sandstone. At Ucon, Bonneville County, the Misken Stone Co. has operated a quarry for local buildings. Near Archer, Madison County, Charles Briggs has operated the Sunnydell quarry for rough building stone. Both these quarries furnish a coarse-grained white volcanic tuff locally called sandstone. They were idle in 1922.

PACIFIC COAST STATES.

The output of the sandstone quarries of the Pacific Coast States in 1922 was chiefly building stone from the Washington quarries and crushed stone from the California quarries, with small amounts for other uses.

California.—At present no sandstone is being quarried in California for buildings. At one time a fine-grained gray sandstone was quarried at Sites, Colusa County, and used extensively for buildings in San Francisco. The Southern Pacific Co., at Farwell, Alameda County; Bates & Borland (Leona and Hyland quarries) and the Oakland Paving Co., at Oakland, Alameda County; the Daniel Contracting Co. (San Pedro quarries), at McNears Point, Marin County; the Market Street Railway Co., at Daly City, San Mateo County; the Holy Cross Cemetery, at Colma, San Mateo County; and W. A. Wilson, at Cotati, Sonoma County, crush sandstone for road foundation and concrete work. Fehlhaber Bros. quarry sandstone at La Crescenta, Los Angeles County, for the manufacture of silica brick.

Washington.—Sandstone is quarried for buildings in Washington at Wilkeson, Pierce County, by the Walker Cut Stone Co., of Tacoma, and at Tenino, Thurston County, by the Tenino Stone Co. (Inc.). The Tenino stone is a medium-grained sandstone of dark-buff to tawny color above ground-water level and dark-gray below. The dark-gray variety is the principal product at present and is used chiefly for local work, although it has been shipped to California, Idaho, and Oregon. The Wilkeson stone is a medium-grained gray sandstone. It is used locally and in different parts of Washington and is shipped to adjacent States. It is sold as cut stone, sawed stone, rubble, and paving blocks. In 1922 stone from the Wilkeson quarry was furnished for the construction of the State capitol at Olympia.

MISCELLANEOUS STONE.

Practically all the material included under "miscellaneous stone" is used for road metal, concrete, and railroad ballast. The total of these products decreased 15 per cent in 1922. Much of this material is quarried for local use, such as road construction, and the quarries are closed when the construction work is finished.

There was a considerable increase in sales of miscellaneous building stone, much of which is mica schist quarried in Pennsylvania (see p. 331 for names of operators) sold for foundations and other rough work but some of which consists of varieties sold for architectural building stone. The Bly Stone Co., of Los Angeles, Calif., operate the Round Valley tufa quarry at Bishop, Inyo County, Calif. This stone was used in 1922 in the construction of the Automobile Club, the Raymond Avenue School, and the Castellas Street School, at Los Angeles, and the Gardena High School, at Gardena, Calif. The Oregon Volcanic Tuff Products Co., Mount Angel, Marion County, Oreg., quarries volcanic tuff for building stone. Tufa is also quarried on the reservation of the San Carlos Apache Indians at Rice, Gila County, Ariz., for local buildings. At Tempe, Maricopa County, Ariz., andesitic tuff is taken by several contractors from the quarry of the Phoenix-Tempe Stone Co. and crushed for road metal and concrete. Under stone sold for "Other purposes" is included some serpentine quarried in California and Pennsylvania for roofing granules. The total output of roofing granules includes also "red rock," serpentine, "greenstone," marble, and sandstone and in 1922 amounted to 8,330 short tons, valued at $78,166, which combined with the granules reported under "Basalt" (p. 300) makes

a total of 82,410 short tons of stone granules, valued at $593,432, sold as surfacing for prepared roofing in 1922. These stone granules enter into competition with the black, red, green, and gray slate granules of Georgia, Maine, New York, Pennsylvania, Tennessee, Vermont, and Virginia. The production of slate granules in 1922 was 379,980 short tons, valued at $2,177,061. Besides the producers of basalt (altered diabase or "greenstone") mentioned on page 300 the following companies reported sales of roofing granules:

Angels Green Stone Co., Richmond, Calif.
Non-Metallic Minerals Corporation, Los Angeles, Calif.
Rainbow Mining & Mineral Products Co., Los Angeles, Calif.
Veruga Marble Co., San Diego, Calif.
Rock Products Co., Easton, Pa.
Polk County Grinding Co., Dresser Junction, Wis.

Under stone for "Other uses" is also included stone for poultry grit and stucco work and mica schist for furnace, converter, and kiln linings, for which a list of operators is given on page 330.

Miscellaneous varieties of stone [a] sold in the United States in 1921 and 1922.

Use.	1921		1922	
	Quantity.	Value.	Quantity.	Value.
Building stone.....cubic feet..	300,000	$50,062	1,053,320	$141,769
Approximate equivalent in short tons.....	25,060	.....	88,480	.....
Riprap and rubble.....short tons..	75,750	77,409	50,670	42,250
Crushed stone.....do....	1,560,870	1,909,810	1,328,900	1,493,433
Refractory stone.....do....	12,020	35,667	30,670	82,671
Other.....do....	11,520	90,853	22,160	126,683
Total (quantities approximate, in short tons)....	1,685,220	2,163,801	1,520,880	1,886,806

[a] Includes mica schist, conglomerate, argillite, various light volcanic rocks, serpentine not used as marble, and such other stone as can not be properly classed in any of the main groups.

Miscellaneous varieties of stone sold in the United States in 1922, by States and uses.

State.	Number of active plants.	Rough construction.		Riprap and rubble.		Crushed stone. Road metal and concrete.	
		Short tons (approximate).	Value.	Short tons.	Value.	Short tons.	Value.
Arizona	4	10	$30	1,730	$845	8,290	$13,510
Arkansas	2					(a)	(a)
California	14	(a)	(a)	(a)	(a)	552,070	502,489
Florida	1					(a)	(a)
Idaho	1	(a)	(a)				
Massachusetts	11	2,920	3,240	6,000	7,500	230,110	350,942
New Hampshire	1						
New Jersey	1	(a)	(a)			(a)	(a)
New York	2					(a)	(a)
Oregon	1	(a)	(a)				
Pennsylvania	17	35,160	62,827			56,540	89,740
Rhode Island	4					36,670	73,513
South Dakota	1					4,000	5,680
Virginia	1					(a)	(a)
Wisconsin	1			(a)	(a)	(a)	(a)
Wyoming	1						
Undistributed		50,390	75,672	42,940	33,905	262,170	385,207
	63	88,480	141,769	50,670	42,250	1,149,850	1,421,081

State.	Number of active plants.	Crushed stone. Railroad ballast.		Other.		Total.	
		Short tons.	Value.	Short tons.	Value.	Short tons (approximate).	Value.
Arizona	4					10,030	$14,385
Arkansas	2	(a)	(a)	(a)	(a)	(a)	(a)
California	14	154,860	$42,938	7,840	$71,966	801,680	702,165
Florida	1					(a)	(a)
Idaho	1					(a)	(a)
Massachusetts	11					239,030	361,682
New Hampshire	1			11,690	23,217	11,690	23,217
New Jersey	1					(a)	(a)
New York	2	(a)	(a)			(a)	(a)
Oregon	1					(a)	(a)
Pennsylvania	17	4,190	6,061	b32,800	b102,421	128,690	261,049
Rhode Island	4					36,670	73,513
South Dakota	1					4,000	5,680
Virginia	1					(a)	(a)
Wisconsin	1					(a)	(a)
Wyoming	1			(a)	(a)	(a)	(a)
Undistributed		20,000	23,353	500	11,750	289,090	445,115
	63	179,050	72,352	52,830	209,354	1,520,880	1,886,806

a Included under "Undistributed."
b Includes 30,670 short tons of mica schist, valued at $82,671, used for lining kilns and furnaces.

CRUSHED STONE.

There was an increase of 15 per cent in the quantity of crushed stone sold in the United States in 1922 compared with 1921. Stone sold for road metal and concrete increased 15 per cent, and that sold for railroad ballast increased 14 per cent. Besides this a considerable amount of stone was crushed by portable roadside crushers, which were abandoned after the needs of a particular piece of road were supplied. These crushers are run by local contractors and township or county officials, from whom it is impossible to collect figures. Transportation difficulties and uncertain building conditions had an adverse influence on the crushed-stone industry during 1922, and few plants were operated to capacity. Many of the larger firms have been reconstructing their quarry and plant equipment and installing modern machinery to reduce the cost of operation to a minimum and also to eliminate hand labor as much as possible. As there has been no decrease in the good-roads movement, although cement rather than macadam roads are more in favor at present, and as transportation difficulties and freight rates are gradually being adjusted, there seems to be no reason why the crushed-stone industry should not continue to improve in 1923.

Crushed stone sold in the United States in 1921 and 1922.

	Road metal and concrete.		Railroad ballast.		Total.		
						Value.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Total.	Average.
1921.							
Granite	2,771,070	$4,032,200	325,340	$414,887	3,096,410	$4,447,087	$1.44
Basalt and related rocks (trap rock)	7,358,230	9,740,418	927,450	1,172,655	8,285,680	10,913,073	1.32
Limestone	23,985,790	27,903,303	4,734,620	4,329,135	28,720,410	32,232,438	1.12
Sandstone	1,190,410	1,808,083	349,060	406,987	1,539,470	2,215,070	1.44
Miscellaneous	1,460,290	1,854,980	106,580	54,830	1,560,870	1,909,810	1.22
	36,765,790	45,338,984	6,437,050	6,378,494	43,202,840	51,717,478	.....
Average value per ton	.....	1.23	.....	0.99	.....	1.20	.....
1922.							
Granite	3,614,250	4,973,646	482,660	441,430	4,096,910	5,415,076	1.32
Basalt and related rocks (trap rock)	8,313,670	10,284,048	1,290,180	1,370,220	9,603,850	11,654,268	1.21
Limestone	27,906,450	28,966,511	4,879,850	4,258,368	32,786,300	33,224,879	1.01
Sandstone	1,442,280	1,937,472	505,500	405,049	1,947,780	2,342,521	1.20
Miscellaneous	1,149,850	1,421,081	179,050	72,352	1,328,900	1,493,433	1.12
	42,426,500	47,582,758	7,337,240	6,547,419	49,763,740	54,130,177	.....
Average value per ton	.....	1.12	.....	0.89	.....	1.09	.....
Percentage of increase in 1922	15	5	14	3	15	5	.....

Crushed stone sold in the United States in 1922, by States and uses.

State.	Concrete and road metal.		Railroad ballast.		Total.	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.
Alabama	25,140	$28,869			25,140	$28,869
Arizona	(a)	(a)	(a)	(a)	27,430	23,333
Arkansas	226,050	296,523	55,040	$51,634	281,090	348,157
California	4,451,950	4,518,968	503,000	326,457	4,954,950	4,845,425
Colorado	b 45,400	b 48,684			b 45,400	b 48,684
Connecticut	1,321,290	1,304,503	39,990	31,000	1,361,280	1,335,503
Delaware	(a)	(a)			(a)	(a)
Florida	b 587,050	b 482,568	(a)	(a)	798,150	731,501
Georgia	188,460	267,959	2,530	2,640	190,990	270,599
Hawaii	209,630	389,351	(a)	(a)	b 209,630	b 389,351
Idaho	b 126,120	b 160,400			b 126,120	b 160,400
Illinois	4,740,350	4,487,988	609,100	501,650	5,349,450	4,989,638
Indiana	1,625,930	1,488,107	177,620	138,524	1,803,550	1,626,631
Iowa	417,550	451,943	5,640	5,171	423,190	457,114
Kansas	412,170	624,699	205,690	201,571	617,860	826,270
Kentucky	777,740	927,500	653,440	557,591	1,431,180	1,485,091
Louisiana	b 570	b 568	500	500	b 1,070	b 1,068
Maine	b 3,850	b 6,110	b 540	b 519	12,250	15,651
Maryland	489,340	702,808	151,590	191,207	640,930	894,015
Massachusetts	1,249,840	1,700,820	78,980	63,385	1,328,820	1,764,205
Michigan	1,081,840	765,665	38,300	33,024	1,120,140	798,689
Minnesota	513,870	745,394	(a)	(a)	b 513,870	b 745,394
Missouri	b 967,230	b 1,354,582	135,910	135,930	b 1,103,140	b 1,490,512
Montana	43,560	46,329	(a)	(a)	b 43,560	b 46,329
Nebraska	141,210	177,825			141,210	177,825
New Hampshire	55,460	100,031	1,300	1,374	56,760	101,405
New Jersey	1,464,190	2,295,279	187,930	227,246	1,652,120	2,522,525
New Mexico	2,430	1,748	b 362,190	b 214,102	b 364,620	b 215,850
New York	b 4,143,400	b 4,988,542	b 889,780	b 818,086	b 5,033,180	b 5,806,628
North Carolina	816,190	1,273,367			816,190	1,273,367
Ohio	4,993,510	4,360,732	469,940	406,286	5,463,450	4,767,018
Oklahoma	b 816,410	b 943,812	289,570	235,673	b 1,105,980	b 1,179,485
Oregon	546,850	755,438	34,300	36,587	581,150	792,025
Pennsylvania	4,266,980	5,211,048	b 791,040	b 938,285	b 5,058,020	b 6,149,333
Porto Rico	79,280	162,278			79,280	162,278
Rhode Island	67,350	158,282			67,350	158,282
South Carolina	531,200	862,597	86,600	105,509	617,800	968,106
South Dakota	b 96,640	b 141,783	2,000	3,000	b 98,640	b 144,783
Tennessee	528,590	557,359	294,590	236,749	823,180	794,108
Texas	b 976,680	b 868,761	b 167,760	b 90,687	b 1,144,440	b 959,448
Utah	16,660	13,161	(a)	(a)	b 16,660	b 13,161
Vermont	2,160	1,335			2,160	1,335
Virginia	685,130	832,023	b 593,560	b 546,641	b 1,278,690	b 1,378,664
Washington	391,020	464,361	5,630	6,750	396,650	471,111
West Virginia	571,610	583,495	89,050	74,556	660,660	658,051
Wisconsin	b 1,322,870	b 1,406,688	74,200	72,975	b 1,397,070	b 1,479,663
Wyoming	(a)	(a)			(a)	(a)
Undistributed	405,750	622,475	339,930	292,110	499,290	633,297
	42,426,500	47,582,758	7,337,240	6,547,419	49,763,740	54,130,177

a Included under "Undistributed."
b Exclusive of output of certain kinds of stone included under "Undistributed" to conform to previous tables and avoid disclosing confidential information.

CARBON BLACK PRODUCED FROM NATURAL GAS.

By G. B. Richardson.

The carbon black produced from natural gas in the United States in 1922 amounted to 67,795,000 pounds, over 13 per cent more than in 1921. The production by States in 1922 as compared with 1921 is shown in the following table, compiled by H. Backus from reports of 26 producers. Montana, Oklahoma, Pennsylvania, and Wyoming are grouped together so as to avoid revealing the output of individual companies. In 1922, as in 1921, Louisiana and West Virginia produced more than 90 per cent of the total output. Louisiana maintained first place and increased its lead over West Virginia, owing to developments in the Monroe field.

Increased demand for carbon black during the later half of the year, especially by the rubber industry for use in making tires, required practically all the product of the year and, in addition, between 12 and 15 million pounds that had been held in storage. The increased demand was reflected by a rise in spot prices, which went up to 24 cents a pound, as quoted in the Rubber Age. The reported average price for the year at the plants was 8.6 cents a pound.

Carbon black produced from natural gas in the United States in 1921–1922.

State.	Number of producers reporting.	Pounds.	Value at plant.		Average yield per M cubic feet (pounds).	Estimated quantity of natural gas used (M cubic feet).
			Total.	Average (cents).		
1921.						
Kentucky	2	2,697,075	$215,822	8.0	1.8	1,519,000
Louisiana	11	31,003,615	2,949,428	9.5	.97	32,072,000
West Virginia	12	25,073,000	2,204,400	8.8	1.6	15,476,000
Wyoming	2	419,400	37,521	8.9	.5	869,000
Montana	1	573,225	38,707	6.8	.9	629,000
Oklahoma	1					
Pennsylvania	1					
	[a] 23	59,766,315	5,445,878	9.1	1.2	50,565,000
1922.						
Kentucky	3	4,306,875	416,549	9.7	1.9	2,300,000
Louisiana	14	41,966,856	3,564,393	8.5	1.1	38,004,000
West Virginia	11	20,095,481	1,714,576	8.5	1.7	12,087,000
Montana	1	1,425,917	124,100	8.7	1.2	1,238,000
Oklahoma	1					
Pennsylvania	1					
Wyoming	1					
	[a] 26	67,795,129	5,819,618	8.6	1.3	53,629,000

[a] In arriving at total for the United States, a producer operating in more than one State is counted but once.

Summary of statistics of carbon black, 1919–1922.

	1919	1920	1921	1922
Number of producers reporting	17	19	23	26
Quantity produced.....pounds..	52,056,941	51,321,892	59,766,315	67,795,129
Value at plants:				
Total	$3,816,040	$4,032,286	$5,445,878	$5,819,618
Average per pound.....cents..	7.3	7.9	9.1	8.6
Estimated quantity of natural gas used...M cubic feet..	49,896,000	40,599,000	50,565,000	53,629,000
Average yield per M cubic feet.....pounds..	1.0	1.3	1.2	1.3

NATURAL-GAS GASOLINE.

By G. B. Richardson.

The raw (unblended) natural-gas gasoline produced in the United States in 1922 amounted to 505,832,000 gallons, having a value at the plants of $72,711,063, an average of 14.4 cents a gallon, according to reports received by the Geological Survey from 402 producers. In the production of this gasoline some 545 billion cubic feet of natural gas was treated, or approximately 71 per cent of the total quantity consumed for the year, the average yield being thus 0.9 gallon of gasoline per M cubic feet of gas. Compared with results in 1921 the production of natural-gas gasoline increased 12 per cent. The gasoline produced from natural gas in the United States in 1922 was equivalent to approximately 8 per cent of the quantity produced from petroleum. The following tables were compiled by E. M. Seeley:

Summary of statistics of natural-gas gasoline, 1918–1922.

	1918	1919	1920	1921	1922
Number of plants reported	1,004	1,191	1,154	[a] 1,058	917
Quantity produced (gallons):					
Compression	219,767,207	261,157,587	281,131,973	[a]331,867,447	285,670,163
Absorption	62,768,343	90,377,439	103,611,949	[a]118,066,955	182,209,056
Combination		[b]	[b]	[b]	36,035,999
Drip	[c]	[c]	[c]	[c]	1,916,782
	282,535,550	351,535,026	384,743,922	449,934,402	505,832,000
Value at plants:					
Total	$50,363,535	$64,196,763	$71,788,122	$61,815,258	$72,711,063
Average per gallon (cents)	17.8	18.3	18.7	13.7	14.4
Estimated quantity of natural gas treated (M cubic feet)	449,108,661	480,403,963	496,430,952	[a]465,097,400	545,139,375
Average yield per M cubic feet (gallon)	0.63	0.73	0.78	0.97	0.93

[a] Revised figures.
[b] Included in compression and absorption.
[c] Included in absorption.

Natural-gas gasoline produced in the United States in 1921, by States.

State.	Number of plants.	Gasoline produced.			Gas treated.		Percentage of production.				
		Gallons.	Value.		M cubic feet.	Average yield per M (gallons).	State.		United States.		
			Total.	Average (cents).			Compression.	Absorption.	Compression.	Absorption.	Total.
Oklahoma	280	185,340,742	$22,066,014	11.9	88,380,173	2.10	89	11	49.8	17.0	41.2
Texas	65	77,141,201	9,118,420	11.8	26,460,805	2.92	89	11	20.6	7.3	17.2
California	73	58,220,498	9,874,594	17.0	[a] 55,650,328	1.05	63	37	11.1	18.0	12.9
West Virginia	[a] 181	54,646,053	9,889,861	18.1	[a] 135,161,821	.40	31	69	5.1	32.1	12.2
Pennsylvania	264	19,856,373	3,354,233	16.9	46,336,174	.43	58	42	3.5	7.0	4.4
Louisiana	26	15,340,374	1,812,268	11.8	[a] 45,050,122	.34	46	54	2.1	7.0	3.4
Wyoming	7	14,557,684	1,599,591	11.0	4,559,639	3.19	99	1	4.4	.1	3.2
Ohio	48	9,099,897	1,546,551	17.0	35,888,504	.25	18	82	.5	6.3	2.0
Illinois	90	7,536,073	1,101,227	14.6	3,102,246	2.43	100	----------	2.3	----------	1.7
Kentucky	9	4,241,938	834,983	19.7	16,520,224	.26	5	95	.1	3.4	.9
Kansas	11	3,587,329	565,408	15.8	7,784,339	.46	42	58	.4	1.8	.8
New York	4	366,240	52,108	14.2	203,025	1.80	100	----------	.1	----------	.1
	[a] 1,058	449,934,402	61,815,258	13.7	[a] 465,097,400	.97	73.8	26.2	100.0	100.0	100.0

[a] Revised figures.

Natural-gas gasoline produced in the United States in 1922, by States.

State.	Number of plants reported.	Gasoline produced.			Gas treated.		Percentage of total production.			
		Gallons.	Value.		M cubic feet.	Average yield per M (gallons).	Compression.	Absorption.	Combination.	Drip.
			Total.	Average (cents).						
Oklahoma	267	189,403,670	$24,914,048	13.2	94,799,953	2.00	73.3	25.8	0.5	0.4
Texas	56	95,405,483	12,114,952	12.7	51,243,411	1.86	65.8	33.3	.7	.2
California	77	67,119,700	11,868,152	17.7	61,995,487	1.08	33.6	35.7	30.3	.4
West Virginia	151	56,795,713	9,770,884	17.2	163,138,713	.35	22.2	72.3	5.1	.4
Louisiana	26	29,406,282	4,112,655	14.0	47,143,567	.62	30.6	44.3	23.5	1.6
Wyoming	5	19,967,103	2,251,329	11.3	6,344,245	3.15	99.5	.5		
Pennsylvania	195	18,518,131	3,144,545	17.0	51,328,721	.36	49.2	50.5		.3
Ohio	41	8,600,296	1,300,929	15.1	37,137,163	.23	15.5	84.3		.2
Illinois	78	7,760,011	1,181,797	15.2	3,231,487	2.40	99.9			.1
Kentucky	8	5,204,883	925,810	17.8	18,123,512	.29	10.8	89.2		
Arkansas[a]	1	4,288,955	629,491	14.7	1,193,737	3.59			100.0	
Kansas	8	2,855,573	435,056	15.2	8,187,788	.35	31.8	67.5		.7
New York	4	506,200	61,415	12.1	1,271,591	.40	55.6	44.4		
	917	505,832,000	72,711,063	14.4	545,139,375	.93	56.5	36.0	7.1	.4

[a] Subject to revision.

Natural-gas gasoline produced in the United States in 1921, by methods of manufacture.

Produced by compression and vacuum pumps.

State.	Number of plants.	Gasoline produced.			Gas treated.	
		Gallons.	Value.		M cubic feet.	Average yield per M (gallons).
			Total.	Average (cents).		
Oklahoma [a]	234	[b] 165, 263, 239	[b] $19, 419, 274	11. 8	58, 709, 714	2. 81
Texas [a]	54	68, 492, 568	8, 041, 038	11. 7	13, 956, 183	4. 91
California [c]	43	36, 947, 374	6, 907, 702	18. 7	[b] 46, 413, 420	. 80
West Virginia [d]	[b] 135	16, 788, 069	2, 767, 814	16. 5	12, 419, 275	1. 35
Wyoming	6	14, 495, 141	1, 590, 382	11. 0	4, 430, 742	3. 27
Pennsylvania	235	11, 558, 508	1, 756, 138	15. 2	5, 071, 295	2. 28
Illinois	90	7, 533, 647	1, 100, 800	14. 6	3, 102, 246	2. 43
Louisiana [a]	14	7, 078, 748	706, 022	10. 0	2, 554, 865	2. 77
Ohio	36	1, 642, 813	268, 469	16. 3	808, 740	2. 03
Kansas	8	1, 504, 372	262, 649	17. 5	751, 971	2. 00
New York	4	366, 240	52, 108	14. 2	203, 025	1. 80
Kentucky	6	196, 728	38, 294	19. 5	87, 102	2. 26
	[b] 865	[b] 331, 867, 447	[b] 42, 910, 690	12. 9	[b] 148, 508, 578	2. 23

Produced by absorption. [e]

West Virginia [f]	[b] 52	37, 857, 984	$7, 122, 047	18. 8	123, 992, 569	0. 31
California [g]	30	21, 273, 124	2, 966, 892	13. 9	22, 932, 628	. 93
Oklahoma [a]	47	[b] 20, 077, 503	[b] 2, 646, 740	13. 2	29, 678, 245	. 68
Texas [a]	12	8, 648, 633	1, 077, 382	12. 5	12, 569, 622	. 69
Pennsylvania	29	8, 297, 865	1, 598, 095	19. 3	41, 264, 879	. 20
Louisiana [a]	13	8, 261, 626	1, 106, 246	13. 4	43, 857, 173	. 19
Ohio	12	7, 457, 084	1, 278, 082	17. 1	35, 079, 764	. 21
Kentucky	3	4, 045, 210	796, 689	19. 7	16, 433, 122	. 25
Kansas	3	2, 082, 957	302, 759	14. 5	7, 032, 368	. 30
Wyoming	1	62, 543	9, 209	14. 7	128, 897	[h] . 23
	[b] [i] 202	[b] [j] 118, 066, 955	[b] 18, 904, 568	16. 0	[k] 332, 969, 267	. 35

[a] Includes one combination compression and absorption plant.
[b] Revised figures.
[c] Includes five combination compression and absorption plants, whose entire product is included under compression.
[d] Includes ten combination compression and absorption plants.
[e] Includes drip gasoline.
[f] Includes six combination compression and absorption plants.
[g] Includes three combination compression and absorption plants, whose entire product is included under absorption.
[h] Excludes 33,000 gallons of drip.
[i] Includes nine combination compression and absorption plants duplicated in the total number of compression plants but not duplicated in the total number of plants for the United States.
[j] Includes 2,426 gallons of drip gasoline, valued at $427, produced in Illinois.
[k] Includes 16,380,445 M cubic feet (revised figures) of gas that was first treated at combination plants by compression and that is duplicated in the total volume of gas treated at the compression plants but not duplicated in the total for the States or for the United States on page 348.

Natural-gas gasoline produced in the United States in 1922, by methods of manufacture.

State.	Number of plants reported.			Raw (unblended) gasoline produced (gallons).				Estimated quantity of natural gas treated (M cubic feet).		
	Compression.	Absorption.	Combination.	Compression.	Absorption.	Combination.	Drip.	Compression.	Absorption.	Combination.
Oklahoma	197	69	1	138,906,380	48,871,706	956,300	669,284	45,877,533	48,292,795	629,625
Texas	34	20	2	62,795,311	31,778,874	645,759	185,539	12,242,870	38,075,041	925,500
California	27	36	14	22,558,064	23,957,658	20,314,017	289,961	16,239,625	21,667,704	24,088,158
West Virginia	85	56	10	12,590,768	41,090,236	2,905,960	208,749	7,131,093	151,464,086	4,543,534
Louisiana	13	10	3	8,998,040	13,016,234	6,925,008	467,000	1,877,599	43,672,100	1,593,868
Wyoming	4	1		19,869,377	97,726			5,551,856	792,389	
Pennsylvania	168	27		9,115,645	9,345,221		57,265	4,937,178	46,391,543	
Ohio	29	12		1,333,811	7,253,645		12,840	582,030	36,555,133	
Illinois	78			7,752,396			7,615	3,231,487		
Kentucky	5	3		560,581	4,644,302			106,950	18,016,562	
Arkansas [a]			1			4,288,955				1,193,737
Kansas	5	3		908,590	1,928,454		18,529	302,520	7,885,268	
New York	3	1		281,200	225,000			152,188	1,119,403	
	648	238	31	285,670,163	182,209,056	36,035,999	1,916,782	98,232,929	413,932,024	32,974,422

State.	Percentage of total production.					Average yield per M cubic feet of gas treated (gallons).		
	Compression.	Absorption.	Combination.	Drip.	All methods.	Compression.	Absorption.	Combination.
Oklahoma	48.6	26.8	2.6	34.9	37.4	3.03	1.01	1.52
Texas	22.0	17.4	1.8	9.7	18.9	5.13	.83	.70
California	7.9	13.1	56.4	15.1	13.3	1.39	1.11	.84
West Virginia	4.4	22.6	8.1	10.9	11.2	1.77	.27	.64
Louisiana	3.1	7.1	19.2	24.3	5.8	4.79	.30	4.34
Wyoming	7.0	.1			3.9	3.58	.12	
Pennsylvania	3.2	5.1		3.0	3.7	1.85	.20	
Ohio	.5	4.0		.7	1.7	2.29	.20	
Illinois	2.7			.4	1.5	2.40		
Kentucky	.2	2.6			1.0	5.24	.26	
Arkansas			11.9		.9			3.59
Kansas	.3	1.1		1.0	.6	3.00	.24	
New York	.1	.1			.1	1.85	.20	
	100.0	100.0	100.0	100.0	100.0	2.91	.44	1.09

[a] Subject to revision.

NATURAL GAS.

By G. B. Richardson.

In 1922 the consumption of natural gas in the United States amounted to 762,546,000,000 cubic feet, having an estimated value of $84,873,000 at the wells and of $221,535,000 at points of consumption. This is 15 per cent more than the quantity consumed in 1921 and 4 per cent less than that consumed in the record year, 1920. One-third of the natural gas consumed in 1922 was used for domestic purposes by 3,015,000 consumers, and the rest was used by the industries.

Increased production is recorded for most of the States, and in the leading five—West Virginia, Oklahoma, Pennsylvania, California, and Louisiana—gains were made ranging between 8 and 20 billion cubic feet. Only a few changes were recorded in the rank of the States in production. Wyoming, with an increase of 50 per cent in output, attained eighth place, passing Kansas; and Arkansas, with an increase of more than 125 per cent, went from twelfth to tenth place, passing Kentucky and New York. In consumption, however, several of the leading States changed positions as compared with 1921. Pennsylvania regained first place, having dropped to third in 1921; Ohio changed from first to second, Oklahoma from second to third, California from fifth to fourth, and West Virginia from fourth to fifth.

The interstate movement of natural gas increased from 150,000,000,000 cubic feet in 1921 to 179,000,000,000 cubic feet in 1922. West Virginia, which contributed 26 per cent of the total production and consumed less than 11 per cent, contributed 66 per cent of the gas that was transported to other States.

During the last few years there has been a considerable increase in the unit value of natural gas, the average value at the points of consumption increasing from 21.6 cents per M cubic feet in 1919 to 29.1 cents in 1922. The average value per M cubic feet of the gas used in domestic consumption has increased more than 15 cents in the last four years and in 1922 was 49.9 cents. The following tables were compiled by H. Backus.

Summary of statistics of natural gas, 1919–1922.

	1919	1920	1921	1922
Natural gas consumed (M cubic feet):				
Domestic consumption	255,743,000	286,001,000	248,334,000	254,413,000
Industrial consumption—				
Carbon black	49,896,000	40,599,000	50,565,000	53,629,000
Field use	169,787,000	202,108,000	182,305,000	197,850,000
Other industrial	270,490,000	269,502,000	180,848,000	256,654,000
	745,916,000	798,210,000	662,052,000	762,546,000
Domestic—per cent	34.3	35.8	37.5	33.4
Industrial—do	65.7	64.2	62.5	66.6
Domestic consumers	2,501,000	2,615,000	2,631,000	3,015,000
Value of natural gas at wells:				
Total	(a)	(a)	(a)	$84,873,000
Average per M cubic feet, cents				11.1
Value of natural gas at points of consumption:				
Total	$160,888,000	$196,194,000	$174,617,000	$221,535,000
For domestic purposes	88,414,000	109,302,000	110,337,000	126,902,000
For industrial purposes	72,474,000	86,892,000	64,280,000	94,633,000
Average per M cubic feet (cents)—				
For domestic purposes	34.6	38.2	44.4	49.9
For industrial purposes	14.8	17.0	15.5	18.6
Domestic and industrial	21.6	24.6	26.4	29.1
By-products of natural gas:				
Natural-gas gasoline—				
Quantity—gallons	351,500,000	384,700,000	449,900,000	505,800,000
Value at plant—				
Total	$64,197,000	$71,788,000	$61,815,000	$72,711,000
Average per gallon—cents	18.3	18.7	13.7	14.4
Carbon black—				
Quantity—pounds	52,100,000	51,300,000	59,800,000	67,800,000
Value at plant—				
Total	$3,816,000	$4,032,000	$5,446,000	$5,820,000
Average per pound—cents	7.3	7.9	9.1	8.6

[a] Figures not available prior to 1922.

Natural gas produced and consumed in the United States, 1921–22.

State.	Produced and delivered to consumers, including deliveries in other States.						Consumed, including receipts from other States.			
	Quantity.		Estimated value at the wells.		Value at points of consumption.		Quantity.		Value at points of consumption.	
	M cubic feet.	Per cent of total.	Total.	Average per M cubic feet (cents).	Total.	Average per M cubic feet (cents).	M cubic feet.	Per cent of total.	Total.	Average per M cubic feet (cents).
1921.										
Ark	4,260,000	0.6			$984,000	23.1	10,637,000	1.6	$2,451,000	23.0
Calif	75,942,000	11.5			16,496,000	21.7	75,942,000	11.5	16,496,000	21.7
Colo	4,000	(a)			1,000	25.0	4,000	(a)	1,000	25.0
Ill	2,646,000	.4			356,000	13.5	2,630,000	.4	348,000	13.2
Ind	1,066,000	.2			547,000	51.3	2,954,000	.4	1,520,000	51.5
Iowa	700	(a)			300	42.9	700	(a)	300	42.9
Kans	15,717,000	2.4			7,382,000	47.0	26,172,000	4.0	9,602,000	36.7
Ky	4,820,000	.7			1,597,000	33.1	13,667,000	2.1	4,526,000	33.1
La	58,004,000	8.8			5,460,000	9.4	53,027,000	8.0	3,926,000	7.4
Md	200	(a)			100	50.0	625,000	.1	418,000	66.9
Mich	400	(a)			300	75.0	400	(a)	300	75.0
Mo	4,000	(a)			3,000	75.0	4,467,000	.7	3,463,000	77.5
Mont	336,000	(a)	(b)	(b)	89,300	26.6	336,000	(a)	89,300	26.6
N. Y	6,583,000	1.0			2,798,000	42.5	15,541,000	2.3	6,596,000	42.4
N. Dak	1,000	(a)			400	40.0	1,000	(a)	400	40.0
Ohio	47,412,000	7.2			19,216,000	40.5	106,051,000	16.0	43,221,000	40.8
Okla	124,058,000	18.7			23,429,000	18.9	100,903,000	15.2	15,989,000	15.8
Oreg	200	(a)			100	50.0	200	(a)	100	50.0
Pa	86,144,000	13.0			32,815,000	38.1	100,615,000	15.2	38,246,000	38.0
S. Dak	9,700	(a)			4,000	41.2	9,700	(a)	4,000	41.2
Tenn	11,000	(a)			2,600	23.6	11,000	(a)	2,600	23.6
Tex	44,504,000	6.7			8,893,000	20.0	51,341,000	7.8	10,720,000	20.9
W. Va	174,920,800	26.4			52,827,900	30.2	81,509,000	12.3	15,282,000	18.7
Wyo	15,608,000	2.3			1,715,000	11.0	15,608,000	2.3	1,715,000	11.0
	662,052,000	100.0			174,617,000	26.4	662,052,000	100.0	174,617,000	26.4
1922.										
Ark	9,700,000	1.3	$873,000	9.0	1,798,000	18.5	17,826,000	2.3	3,306,000	18.5
Calif	84,580,000	11.1	7,612,000	9.0	17,898,000	21.2	84,580,000	11.1	17,898,000	21.2
Colo	4,000	(a)	400	10.0	560	14.0	4,000	(a)	560	14.0
Ill	3,383,000	.4	372,100	11.0	424,040	12.5	3,383,000	.4	424,040	12.5
Ind	947,000	.1	284,100	30.0	476,172	50.3	3,263,000	.4	1,641,000	50.3
Iowa	500	(a)	56	11.2	250	50.0	500	(a)	250	50.0
Kans	20,289,000	2.7	1,826,000	9.0	9,123,000	45.0	28,348,000	3.7	10,315,000	36.4
Ky	5,872,000	.8	646,000	11.0	1,879,000	32.0	15,268,000	2.0	4,884,000	32.0
La	70,267,000	9.2	2,108,000	3.0	5,849,000	8.3	65,987,000	8.7	4,476,000	6.8
Md							705,000	.1	472,000	67.0
Mich	700	(a)	78	11.1	350	50.0	700	(a)	350	50.0
Mo	2,600	(a)	289	11.1	2,028	78.0	4,873,600	.6	3,802,000	78.0
Mont	486,000	(a)	24,245	5.0	88,300	18.2	486,000	(a)	88,300	18.2
N. Y	6,947,000	.9	1,598,000	23.0	3,379,000	48.6	15,777,000	2.1	7,676,000	48.7
N. Dak	600	(a)	67	11.1	300	50.0	600	(a)	300	50.0
Ohio	51,481,000	6.7	9,267,000	18.0	24,181,000	47.0	116,127,000	15.2	55,062,000	47.4
Okla	140,631,000	18.4	15,469,000	11.0	33,475,800	23.8	111,681,000	14.6	24,800,000	22.2
Pa	101,276,000	13.3	20,255,000	20.0	39,835,000	39.3	130,733,000	17.2	50,657,000	38.7
S. Dak	15,600	(a)	1,732	11.1	6,400	41.0	15,600	(a)	6,400	41.0
Tenn	3,000	(a)	333	11.1	800	26.7	3,000	(a)	800	26.7
Tex	47,945,000	6.3	3,835,600	8.0	10,623,000	22.2	60,119,000	7.9	14,165,000	23.6
W. Va	195,288,000	25.6	19,529,000	10.0	69,464,000	35.6	79,938,000	10.5	18,829,000	23.6
Wyo	23,427,000	3.1	1,171,000	5.0	3,031,000	12.9	23,427,000	3.1	3,031,000	12.9
	762,546,000	100.0	84,873,000	11.1	221,535,000	29.1	762,546,000	100.0	221,535,000	29.1

[a] Less than 0.1 per cent.

[b] Figures not available prior to 1922.

Interstate transportation of natural gas, 1921–22.

State in which gas was produced.	State to which gas was transported.	M cubic feet.
1921.		
Illinois	Indiana	16,000
Indiana	Kentucky	8,000
Kansas	Missouri	4,264,000
	Oklahoma	588,000
		4,852,000
Louisiana	Arkansas	4,534,000
	Texas	3,396,000
		7,930,000
New York	Pennsylvania	12,000
Ohio	Indiana	1,880,000
	West Virginia	1,276,000
		3,156,000
Oklahoma	Arkansas	1,843,000
	Kansas	15,307,000
	Missouri	199,000
	Texas	6,394,000
		23,743,000
Pennsylvania	Ohio	64,000
	New York	8,970,000
	West Virginia	1,700,000
		10,734,000
Texas	Louisiana	2,953,000
West Virginia	Maryland	624,800
	Kentucky	8,839,000
	Ohio	61,731,000
	Pennsylvania	25,193,000
		96,387,800
		149,791,800

State in which gas was produced.	State to which gas was transported.	M cubic feet.
1922.		
Indiana	Kentucky	4,000
Kansas	Missouri	4,327,000
	Oklahoma	425,000
		4,752,000
Louisiana	Arkansas	6,123,000
	Texas	2,169,000
		8,292,000
New York	Pennsylvania	19,000
Ohio	Indiana	2,320,000
	West Virginia	1,234,000
		3,554,000
Oklahoma	Arkansas	2,003,000
	Kansas	12,811,000
	Missouri	544,000
	Texas	14,017,000
		29,375,000
Pennsylvania	New York	8,849,000
	Ohio	71,000
	West Virginia	1,910,000
		10,830,000
Texas	Louisiana	4,012,000
West Virginia	Kentucky	9,392,000
	Maryland	705,000
	Ohio	68,129,000
	Pennsylvania	40,268,000
		118,494,000
		179,332,000

State.	Domestic.				Industrial.											
	Number of consumers.	M cubic feet	Value at points of consumption.		Number of consumers.	Field (drilling, pumping, and gasoline extraction plants).			Carbon black.			Other industrial.			Total industrial.		
			Total.	Average (cents).		M cubic feet.	Value at points of consumption.		M cubic feet.	Value at points of consumption.		M cubic feet.	Value at points of consumption.		M cubic feet.	Value at points of consumption.	
							Total.	Average (cents).		Total.	Average (cents).		Total.	Average (cents).		Total.	Average (cents).
Ark	34,794	4,026,000	$1,596,000	39.6	232	391,000	$16,000	4.1				6,220,000	$839,000	13.5	6,611,000	$855,000	12.9
Calif	217,568	11,091,000	8,684,000	78.3	1,528	46,359,000	5,239,000	11.3				18,492,000	2,573,000	13.9	64,851,000	7,812,000	12.0
Colo	10	4,000	1,000	25.0													
Ill	4,058	208,000	102,000	49.0	105	2,405,000	241,000	10.0				17,000	5,000	29.4	2,422,000	246,000	10.2
Ind	35,183	2,120,000	1,147,000	54.1	296	92,000	22,000	23.9				742,000	351,000	47.3	834,000	373,000	44.7
Iowa	4	700	300	42.9													
Kans	128,830	12,387,000	6,799,000	54.9	391	2,683,000	325,000	12.1				11,102,000	2,478,000	22.3	13,785,000	2,803,000	20.3
Ky	100,800	8,749,000	3,617,000	41.3	117	1,076,000	244,000	22.7	1,519,000	$61,000	4.0	2,323,000	604,000	26.0	4,918,000	909,000	18.5
La	23,043	3,417,000	979,000	28.7	713	10,730,000	1,198,000	11.2	32,072,000	883,800	2.8	6,808,000	865,200	12.7	49,610,000	2,947,000	5.9
Md	10,795	559,000	382,000	68.3	19							66,000	36,000	54.5	66,000	36,000	54.5
Mich	8	400	300	75.0													
Mo	78,525	4,449,000	3,452,000	77.6	76							18,000	11,000	61.1	18,000	11,000	61.1
Mont	1,018	138,000	82,190	59.5	3	2,000	300	15.0	182,000	4,000	2.2	14,000	2,900	20.7	198,000	7,200	3.6
N. Y	169,957	14,851,000	6,377,000	42.9	386	364,000	81,000	22.3				326,000	138,000	42.3	690,000	219,000	31.7
N. Dak	4	1,000	400	40.0													
Ohio	959,240	83,753,000	35,529,000	42.4	2,740	3,610,000	937,000	26.0				18,688,000	6,755,000	36.1	22,298,000	7,692,000	34.5
Okla	135,778	17,708,000	6,407,000	36.2	2,695	56,283,000	6,190,000	11.0	432,000	13,000	3.0	26,480,000	3,379,000	12.8	83,195,000	9,582,000	11.5
Oreg	2	200	100	50.0													
Pa	468,615	53,950,000	23,518,000	43.6	7,864	7,745,000	1,733,000	22.4	15,000	1,200	8.0	38,905,000	12,993,800	33.4	46,665,000	14,728,000	31.6
S. Dak	42	4,100	2,000	48.8	1							5,600	2,000	35.7	5,600	2,000	35.7
Tenn	73	3,600	1,600	44.4	1	6,000	900	15.0				1,400	100	7.1	7,400	1,000	13.5
Tex	117,843	10,089,000	5,680,000	56.3	1,509	32,686,000	3,533,000	10.8				8,566,000	1,507,000	17.6	41,252,000	5,040,000	12.2
W. Va	139,010	19,470,000	5,517,200	28.3	2,244	10,717,000	1,586,800	14.8	15,476,000	1,083,000	7.0	35,846,000	7,095,000	19.8	62,039,000	9,764,800	15.7
Wyo	5,715	1,355,000	463,000	34.2	69	7,156,000	302,000	4.2	869,000	27,000	3.1	6,228,000	923,000	14.8	14,253,000	1,252,000	8.8
	2,630,915	248,334,000	110,337,000	44.4	20,989	182,305,000	21,649,000	11.9	50,565,000	2,073,000	4.1	180,848,000	40,558,000	22.4	413,718,000	64,280,000	15.5

Natural gas consumed in the United States in 1922.

State.	Domestic.				Industrial.											
	Number of consumers.	M cubic feet.	Value at points of consumption.		Number of consumers.	Field (drilling, pumping, and gasoline extraction plants).			Carbon black.			Other industrial.			Total industrial.		
			Total.	Average (cents).		M cubic feet.	Value at points of consumption.		M cubic feet.	Value at points of consumption.		M cubic feet.	Value at points of consumption.		M cubic feet.	Value at points of consumption.	
							Total.	Average (cents).		Total.	Average (cents).		Total.	Average (cents).		Total.	Average (cents).
Ark	32,100	4,423,000	$1,637,000	37.0	310	5,343,000	$352,000	6.6				8,060,000	$1,317,000	16.3	13,403,000	$1,669,000	12.5
Calif	428,960	12,802,000	10,056,000	78.6	1,200	47,655,000	3,515,000	7.4				24,123,000	4,326,000	17.9	71,778,000	7,841,000	10.9
Colo	7	4,000	560	14.0													
Ill	8,900	286,000	140,840	49.2	45	3,067,000	277,000	9.0				30,000	6,200	20.7	3,097,000	283,200	9.1
Ind	39,120	1,767,000	1,075,800	60.9	320	85,000	20,000	23.5				1,411,000	545,200	38.6	1,496,000	565,200	37.8
Iowa	3	500	250	50.0													
Kans	128,580	11,518,000	7,166,000	62.2	200	3,801,000	653,000	17.2				13,029,000	2,496,000	19.2	16,830,000	3,149,000	18.7
Ky	111,595	9,649,000	3,984,000	41.3	47	535,000	101,000	18.9	2,300,000	$92,000	4.0	2,784,000	707,000	25.4	5,619,000	900,000	16.0
La	26,070	3,383,000	1,006,000	29.7	725	18,429,000	1,718,000	9.3	38,004,000	760,000	2.0	6,171,000	992,000	16.1	62,604,000	3,470,000	5.5
Md	11,045	568,000	399,000	70.2	30							137,000	73,000	53.3	137,000	73,000	53.3
Mich	9	700	350	50.0													
Mo	85,600	4,639,600	3,732,000	80.4	75							234,000	70,000	29.9	234,000	70,000	29.9
Mont	1,230	148,000	79,600	53.8	5	15,000	2,000	13.3	322,000	6,500	2.0	1,000	200	20.0	338,000	8,700	2.6
N. Y	174,070	15,115,000	7,422,000	49.1	380	262,000	38,000	14.5				400,000	216,000	54.0	662,000	254,000	38.4
N. Dak	3	600	300	50.0													
Ohio	984,300	84,176,000	41,966,000	49.9	3,325	2,880,000	936,000	32.5				29,071,000	12,160,000	41.8	31,951,000	13,096,000	41.0
Okla	136,600	17,403,000	7,558,000	43.4	2,150	56,208,000	11,768,000	20.9	520,000	21,000	4.0	37,550,000	5,454,000	14.5	94,278,000	17,243,000	18.3
Pa	534,100	54,984,000	27,066,000	49.2	4,590	4,900,000	1,182,000	24.1	16,000	1,300	8.1	70,833,000	22,407,700	31.6	75,749,000	23,591,000	31.1
S. Dak	365	10,200	5,100	50.0	1							5,400	1,300	24.1	5,400	1,300	24.1
Tenn	3	400	200	50.0	2							2,600	600	23.1	2,600	600	23.1
Tex	157,530	11,331,000	6,946,000	61.3	1,590	36,288,000	5,003,000	13.8				12,500,000	2,216,000	17.7	48,788,000	7,219,000	14.8
W. Va	146,430	20,742,000	6,114,000	29.5	2,185	8,867,000	1,497,000	16.9	12,087,000	1,039,700	8.6	38,242,000	10,178,300	26.6	59,196,000	12,715,000	21.5
Wyo	7,980	1,462,000	547,000	37.4	80	9,515,000	382,000	4.0	380,000	13,000	3.4	12,070,000	2,089,000	17.3	21,965,000	2,484,000	11.3
	3,014,600	254,413,000	126,902,000	49.9	17,260	197,850,000	27,444,000	13.9	53,629,000	1,933,500	3.6	256,654,000	65,255,500	25.4	508,133,000	94,633,000	18.6

PETROLEUM.

By G. B. Richardson.[1]

INTRODUCTION.

In 1922 the United States attained another high record in the production of petroleum. Its output of more than 557 million barrels, an increase of 18 per cent over the yield of 1921, was 65 per cent of the world's total. In addition to the large domestic production, imports of crude oil exceeded 127 million barrels, and, in spite of unprecedented consumption and exports, stocks of crude oil increased more than 82 million barrels. At the end of the year producers', pipe-line, and tank-farm stocks amounted to the unprecedented quantity of more than 273 million barrels—a quantity sufficient, at the average annual rate of deliveries to domestic consumers and exports, for 165 days, as contrasted with a supply for 130 days at the end of 1921. This condition of oversupply was reflected in a downward trend in prices of crude oil, in contrast with a slight upward movement in the wholesale price of all commodities. The increased production was due chiefly to flush output of recently developed fields in California, Oklahoma, Texas, Arkansas, and Louisiana, together with sustained output from most of the older producing territory. Drilling activity was maintained at a high rate, more than 24,000 wells being drilled for oil and gas during the year—an increase of almost 3,000 over those drilled in 1921 but 9,000 less than the number drilled in 1920. At the end of 1922 there were approximately 285,000 productive oil wells in the United States. Summarized data concerning production, imports, exports, deliveries, and stocks of crude petroleum for 1922 and a number of preceding years are given in the accompanying tables and diagram (fig. 9), and more detailed statistics follow.

Condensed summary of statistics of crude petroleum, 1918–1922.

[Thousands of barrels of 42 U. S. gallons.]

	1918	1919	1920	1921	1922
Production	355 928	378,367	442,929	472,183	557,531
Imports	37,736	52,822	106,175	125,364	127,308
Withdrawn from stocks[a]	23,510	.....	.....	.....	.....
	417,174	431,189	549,104	597,547	684,839
Indicated deliveries to domestic consumers	412,273	420,462	530,532	526,032	592,432
Exports	4,901	6,019	8,757	8,940	10,163
Added to stocks[a]	.....	4,708	9,815	62,575	82,244
	417,174	431,189	549,104	597,547	684,839

[a] Pipe-line, tank-farm, and producers' stocks of domestic petroleum and stocks of Mexican petroleum held in the United States by importers.

[1] The tables in this report have been prepared, unless otherwise indicated, by Misses A. B. Coons, M. N. Schellenger, A. L. Clapp, and C. M. Shanner and Mrs. B. L. Thompson, of the United States Geological Survey.

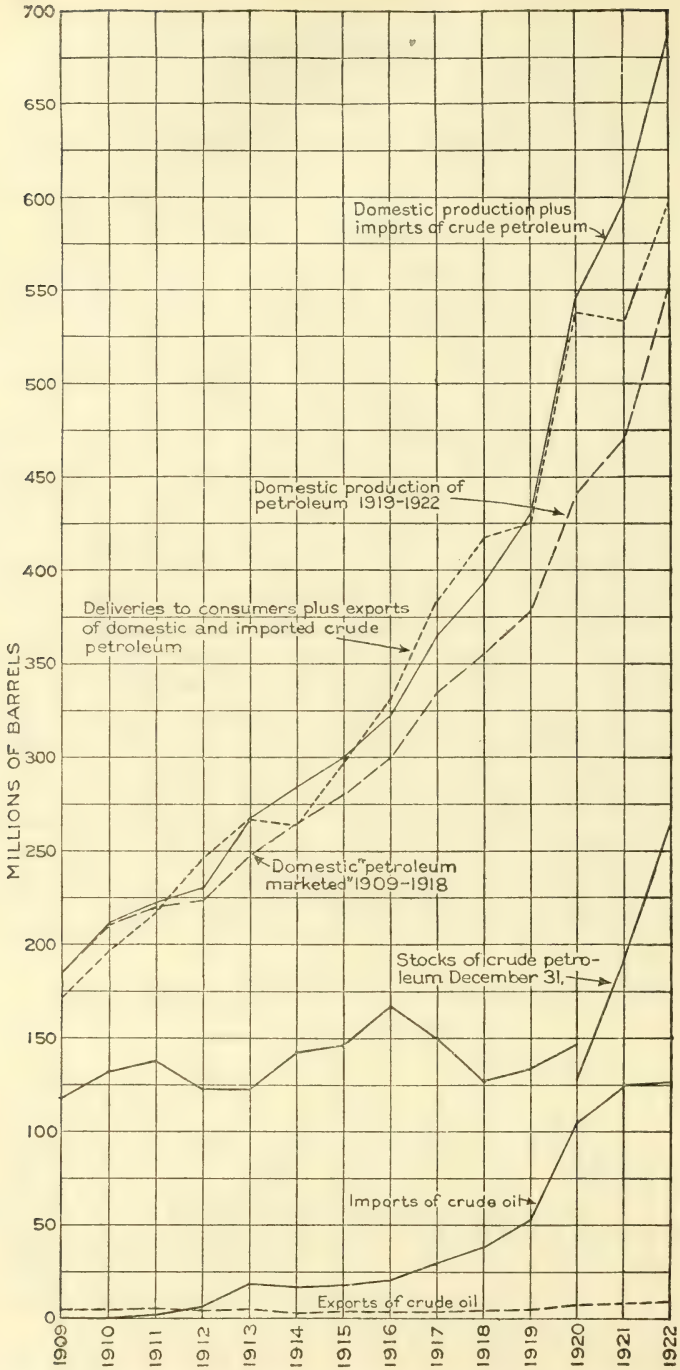

FIGURE 9.—Production, imports, exports, deliveries, and stocks of crude petroleum, 1909–1922.

Supply and demand for crude petroleum, also index numbers for wholesale price of all commodities and price of Oklahoma-Kansas grade crude oil.

Monthly averages by years, 1913–1922.

	Production.		Imports.		Stocks at beginning of period.[a]		Supply.		Indicated deliveries to domestic consumers.		Exports.		Demand.		Wholesale price of all commodities (index No.[b]).	Price of Oklahoma-Kansas grade crude oil.	
	Thousands of barrels.	Index No.[b]	Thousands of barrels.	Index No.[b]	Thousands of barrels.	Index No.[b]	Thousands of barrels.	Index No.[b]	Thousands of barrels.	Index No.[b]	Thousands of barrels.	Index No.[b]	Thousands of barrels.	Index No.[b]		Dollars.	Index No.[b]
1913	20,704	100	1,415	100	122,870	100	144,989	100	21,738	100	386	100	22,124	100	100	0.939	100
1914	22,147	107	1,409	100	122,803	100	146,359	101	21,745	100	248	64	21,993	99	98	.76	81
1915	23,425	113	1,512	107	141,550	115	166,487	115	24,231	111	314	81	24,545	111	101	.60	64
1916	25,064	121	1,733	122	194,185	158	220,982	152	27,035	124	341	88	27,376	124	127	1.26	134
1917	27,943	135	2,511	177	179,372	146	209,826	145	31,526	145	342	89	31,868	144	177	1.81	193
1918	29,661	143	3,145	222	159,452	130	192,258	133	34,356	158	408	106	34,764	157	194	2.20	234
1919	31,531	152	4,402	311	128,586	105	164,519	113	35,039	161	502	130	35,541	161	206	2.28	243
1920	36,911	178	8,848	625	136,213	111	181,972	126	44,211	203	730	189	44,941	203	226	3.42	364
1921	39,349	190	10,447	738	{c146,028 d128,187	119 104	c195,824 d177,983	135 123	43,836	202	745	193	44,581	202	147	1.65	176
1922	46,461	224	10,609	750	190,762	155	247,832	171	49,369	227	847	219	50,216	227	149	e1.48	158

By months, 1918–1922.

1918.																	
January	27,330	132	2,222	157	150,063	122	179,615	124	29,776	138	410	106	30,186	136	184	2.00	213
February	25,856	125	2,128	150	149,429	122	177,413	122	29,080	134	470	122	29,550	134	186	2.00	213
March	29,665	143	2,557	181	147,863	120	180,085	124	33,688	155	209	54	33,897	153	187	2.10	224
April	28,965	140	2,846	201	146,188	119	177,999	123	32,943	152	385	100	33,328	151	190	2.25	240
May	30,390	147	3,622	256	144,671	118	178,683	123	35,590	164	414	107	36,004	163	190	2.25	240
June	29,854	144	2,915	206	142,679	116	175,448	121	29,244	135	564	146	29,808	135	191	2.25	240
July	31,817	154	2,851	201	145,640	119	180,308	124	38,217	176	477	124	38,694	175	196	2.25	240
August	30,646	148	4,090	289	141,614	115	176,350	122	36,682	169	227	59	36,909	167	200	2.25	240
September	30,436	147	3,505	248	139,441	113	173,382	120	37,176	171	513	133	37,689	170	204	2.25	240
October	31,258	151	3,675	260	135,693	110	170,626	118	36,349	167	677	175	37,026	167	202	2.25	240
November	29,914	144	4,341	307	133,600	109	167,855	116	36,983	170	226	59	37,209	168	203	2.25	240
December	29,797	144	2,984	211	130,646	106	163,427	113	36,545	168	329	85	36,874	167	202	2.25	240

[a] Stocks in table "Monthly averages by years, 1913–1922," include producers', pipe-line, and tank-farm stocks of domestic petroleum and since 1919 stocks of Mexican petroleum held in the United States by importers. Stocks in the table "By months, 1918–1922," include pipe-line and tank-farm stocks of domestic petroleum and since 1919 stocks of Mexican petroleum held in the United States by importers but do not include producers' stocks of domestic petroleum.

[b] Index numbers based on monthly average for 1913=100.

[c] Stocks as reported by unrevised method comparable with preceding years.

[d] Stocks as reported by revised method.

[e] 33°–34.9° gravity.

Supply and demand for crude petroleum, also index numbers for wholesale price of all commodities and price of Oklahoma-Kansas grade crude oil—Continued.

By months, 1918-1922—Continued.

	Production.		Imports.		Stocks at beginning of period.		Supply.		Indicated deliveries to domestic consumers.		Exports.		Demand.		Wholesale price of all commodities (index No.).	Price of Oklahoma-Kansas grade crude oil.	
	Thousands of barrels.	Index No.	Thousands of barrels.	Index No.	Thousands of barrels.	Index No.	Thousands of barrels.	Index No.	Thousands of barrels.	Index No.	Thousands of barrels.	Index No.	Thousands of barrels.	Index No.		Dollars.	Index No.
1919.																	
January	28,835	139	3,899	276	126,553	103	159,287	110	31,633	146	339	88	31,972	145	199	2.25	240
February	26,549	128	3,656	258	127,091	103	157,296	108	30,479	140	184	48	30,663	139	193	2.25	240
March	29,952	145	3,494	247	126,443	103	159,889	110	30,705	141	295	76	31,000	140	196	2.25	240
April	29,628	143	3,984	282	128,648	105	162,260	112	31,527	145	278	72	31,805	144	199	2.25	240
May	30,587	148	4,763	337	130,244	106	165,594	114	35,495	163	177	46	35,672	161	202	2.25	240
June	30,878	149	4,728	334	129,745	106	165,351	114	31,726	146	254	66	31,980	145	203	2.25	240
July	34,020	164	4,518	319	133,163	108	171,701	118	32,116	148	266	53	32,322	146	212	2.25	240
August	33,613	162	4,144	293	139,152	113	176,909	122	41,235	190	192	50	41,427	187	216	2.25	240
September	33,893	164	4,435	313	135,379	110	173,707	120	36,673	169	779	202	37,452	169	210	2.25	240
October	34,214	165	5,917	418	136,113	111	176,244	122	40,289	185	1,124	291	41,413	187	211	2.25	240
November	33,026	160	4,939	349	134,719	110	172,684	119	39,860	183	1,152	298	41,012	185	217	2.34	249
December	33,172	160	4,345	307	131,576	107	169,093	117	38,724	178	1,039	269	39,763	180	223	2.60	277
1920.																	
January	34,008	164	6,294	445	132,124	108	172,426	119	40,876	188	469	121	41,345	187	233	2.96	315
February	33,193	160	4,940	349	131,099	107	169,232	117	38,293	176	853	221	39,146	177	232	3.03	323
March	36,171	174	6,503	460	130,099	106	172,773	119	42,804	197	892	231	43,696	198	234	3.50	373
April	34,945	169	6,186	437	129,108	105	170,239	117	40,954	188	693	180	41,647	188	245	3.50	373
May	36,622	177	6,966	492	128,618	105	172,206	119	42,949	198	761	197	43,710	198	247	3.50	373
June	36,663	177	8,120	574	128,526	105	173,309	120	41,481	191	627	162	42,108	190	243	3.50	373
July	37,746	182	6,768	478	131,229	107	175,743	121	42,935	198	723	187	43,658	197	241	3.50	373
August	38,906	188	10,791	763	132,112	108	181,809	125	47,040	216	553	143	47,593	215	231	3.50	373
September	37,521	181	11,650	823	134,272	109	183,443	127	48,367	222	790	205	49,157	222	226	3.50	373
October	39,584	191	11,361	803	134,360	109	185,305	128	48,307	222	777	201	49,084	222	211	3.50	373
November	38,609	186	13,750	972	136,285	111	188,644	130	48,691	224	796	206	49,487	224	196	3.50	373
December	38,961	188	12,846	908	139,234	113	191,041	132	47,835	220	823	213	48,658	220	179	3.50	373
1921.																	
January	38,138	184	13,258	937	[c] 144,442 [d] 124,601	117 101	[c] 195,838 [d] 175,997	135 121	49,534	228	743	192	50,277	227	170	3.35	357
February	35,524	172	11,384	805	125,589	102	172,497	119	39,362	181	794	206	40,156	182	160	1.88	207
March	41,105	199	12,303	869	132,222	108	185,630	128	45,248	208	750	194	45,998	208	155	1.75	186

April	40,233	194	10,104	714	139,499	114	189,836	131	42,562	196	748	194	43,310	196	148	1.75	186
May	42,189	204	9,148	647	146,399	119	197,736	136	41,463	191	874	226	42,337	191	145	1.51	161
June	40,548	196	10,255	725	155,267	126	206,070	142	42,893	197	586	152	43,479	197	142	1.22	130
July	40,461	195	8,047	569	162,463	132	210,971	146	41,479	191	538	139	42,017	190	141	1.00	106
August	41,109	199	3,352	237	168,821	137	213,282	147	42,583	196	885	229	43,468	196	142	1.00	106
September	36,763	178	9,139	646	169,682	138	215,584	149	41,702	192	881	228	42,583	192	141	1.00	106
October	35,832	173	11,635	822	172,874	141	220,341	152	45,314	208	747	194	46,061	208	142	1.45	154
November	38,108	184	12,986	918	174,149	142	225,243	155	45,987	242	869	225	46,856	212	141	1.90	202
December	42,173	204	13,753	972	178,260	145	234,186	162	47,905	220	525	136	48,430	219	140	2.00	213
1922.																	
January	43,696	211	13,107	926	185,623	151	242,426	167	45,192	208	727	188	45,919	208	138	2.00	213
February	41,314	200	12,077	853	196,228	160	249,619	172	39,933	184	583	151	40,516	183	141	2.00	213
March	47,188	228	14,004	990	208,851	170	270,043	186	47,369	218	806	209	48,175	218	142	2.00	213
April	45,167	218	11,659	824	221,588	180	278,414	192	41,258	190	924	239	42,182	191	143	2.00	213
May	47,002	227	14,018	991	235,962	192	296,982	205	48,838	225	771	200	49,609	224	148	2.00	213
June	46,087	223	12,182	861	247,093	201	305,362	211	48,449	223	826	214	49,275	223	150	2.00	213
July	47,134	228	10,493	742	255,817	208	313,444	216	50,877	234	893	231	51,770	234	155	1.75	186
August	47,059	227	10,279	726	261,395	213	318,733	220	54,983	253	764	198	55,747	252	155	1.26	134
September	45,805	221	*f* 4,812	340	262,707	214	313,324	216	48,166	222	1,127	292	49,293	223	153	1.25	133
October	48,410	234	*g* 10,082	713	263,761	215	322,253	222	56,159	258	741	192	56,900	257	154	1.25	133
November	48,027	232	7,429	525	265,073	216	320,529	221	54,363	250	879	228	55,242	250	156	*e* 1.25	133
December	50,642	245	7,166	506	265,017	216	322,825	223	56,845	262	1,122	291	57,967	262	156	*e* 1.25	133

c Stocks as reported by unrevised method comparable with preceding years.
d Stocks as reported by revised method.
e 33°–34.9° gravity.
f Sept. 1–21.
g Sept. 22–Oct. 31.

RELATION OF PRODUCTION OF PETROLEUM TO GENERAL BUSINESS.

The quantity of petroleum produced each year, unlike the output of most other commodities, is practically independent of general business conditions. The production of pig iron, for instance, fluctuates very closely with the changing phases of recurrent business cycles, in which periods of prosperity, depression, and revival follow one another, but the increase in the annual production of petroleum has progressed almost unchecked. These conditions for the years 1918 to 1922 are illustrated in Figure 10,[2] which shows the daily average production of petroleum and pig iron, by months, contrasted with the index curve of trade[3] depicting fluctuations above and below normal. Although official monthly data for petroleum covering the entire country were not collected prior to 1918 and data of actual production as distinct from "marketed production" (see explanation on p. 369) were not obtained prior to 1919, the available figures indicate that similar conditions have prevailed for many years.

The curves in Figure 10 emphasize the marked contrast in the relative rates of production of petroleum and pig iron. The production of pig iron began to fall off late in 1918, after the end of the war, and dropped to a low level in 1919, but at the end of that year production increased again and during the post-war boom of 1920 it was relatively high. Late in 1920, however, the production of pig iron began to drop again, coincidently with the beginning of the period of severe business depression that culminated in the summer of 1921, when the production of pig iron was at an abnormally low level, after which, with improving business, the production again increased. Throughout this period of marked fluctuations in general business conditions the production of petroleum, on the other hand, was sustained at a high rate. Even in the year of general business depression, 1921, the output of petroleum, notwithstanding a strike in the oil fields of California that caused a temporary drop in the production in September and October, was 29 million barrels greater than that during 1920, when general business was at a much higher level.

The lack of agreement of the curve showing production of petroleum with the index curve of trade is due to conditions that affect the petroleum industry—a steadily growing demand and only a slight control of production. The production of petroleum in the United States has increased almost every year since the beginning of the industry in 1859. The rate of increase has varied, but since 1900 it has been extraordinary, and in 1922 the output was almost 800 per cent greater than in 1900. This large gain has been coincident with the increased demand for petroleum products consequent upon the development of the internal-combustion engine. During the period 1900–1922 the consumption of crude petroleum in the United States increased from less than 1 barrel per capita to more than 5 barrels, and the number of motor-car registrations increased from 1,258,000 in 1913, the first year for which data are available, to 12,238,000 in 1922.

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[2] Smith, Geo. Otis, and others, addresses before the American Statistical Association, Washington, D. C., Dec. 28, 1923.

[3] Harvard Committee of Economic Research.

The production of petroleum differs from the production of most other commodities because of the fortuitous character of the annual new supply. The quantity of petroleum produced in any one year

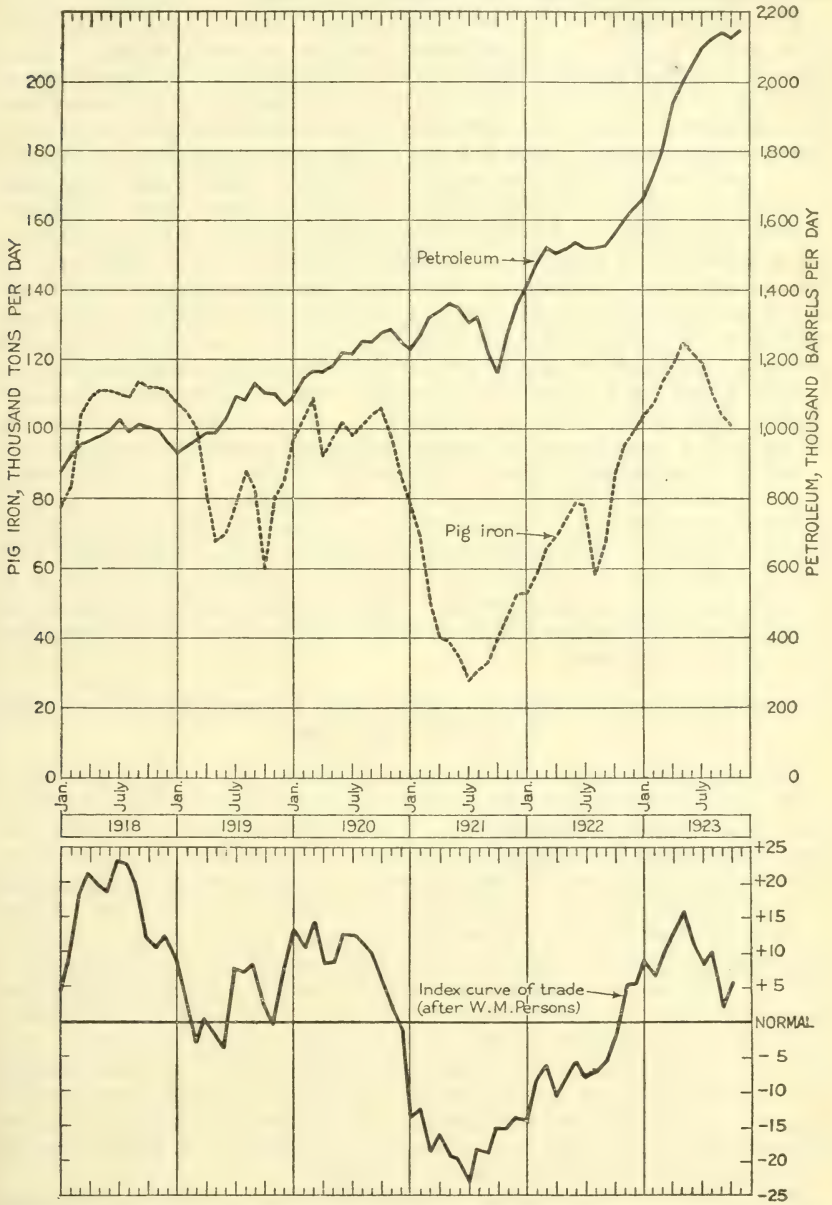


FIGURE 10.—Fluctuations in production of petroleum and pig iron contrasted with the index curve of trade.

is the sum of the sustained production of many thousand wells in previously developed areas, in which there is a normal decline from year to year, plus the flush production of a relatively small number

of wells in newly developed areas. This flush production of new pools causes the increased annual output. The number and productivity of new pools brought in during the last few years have been unprecedented and have caused the present oversupply.

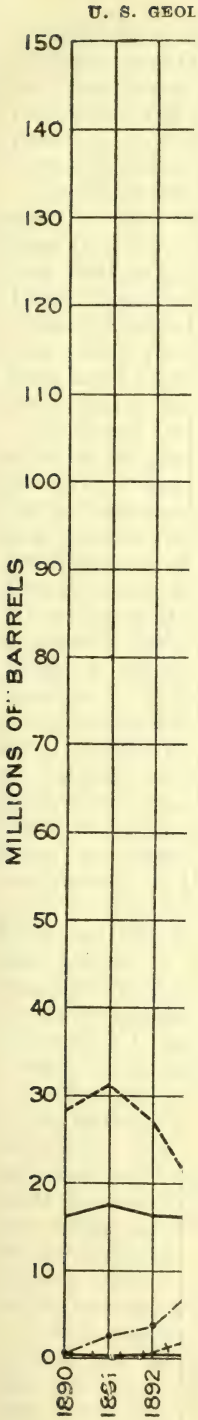
The new supply of domestic petroleum, independent of imports, from year to year can be regulated only to a minor extent. Prospecting is stimulated by high prices for crude oil, and when prices are high more wells are sunk in search of oil than when prices are low. The number of new wells, however, is not the chief factor in causing increased production, for a few wells that open up highly productive new pools are obviously of much more effect than many new wells in old pools or in only moderately productive new ones. The use of applied geology is having an increasing influence in augmenting the production of petroleum by the discovery of new pools and by increasing the production of old ones. But, regardless of the number of wells sunk and of the skill employed in selecting sites and operating properties, whether oil will be found in any particular area and what the yield of a new pool will be—a disappointment like the Teapot dome or a record breaker like Santa Fe Springs—can not be determined in advance of drilling. The element of chance is necessarily a large factor in each year's production of petroleum.

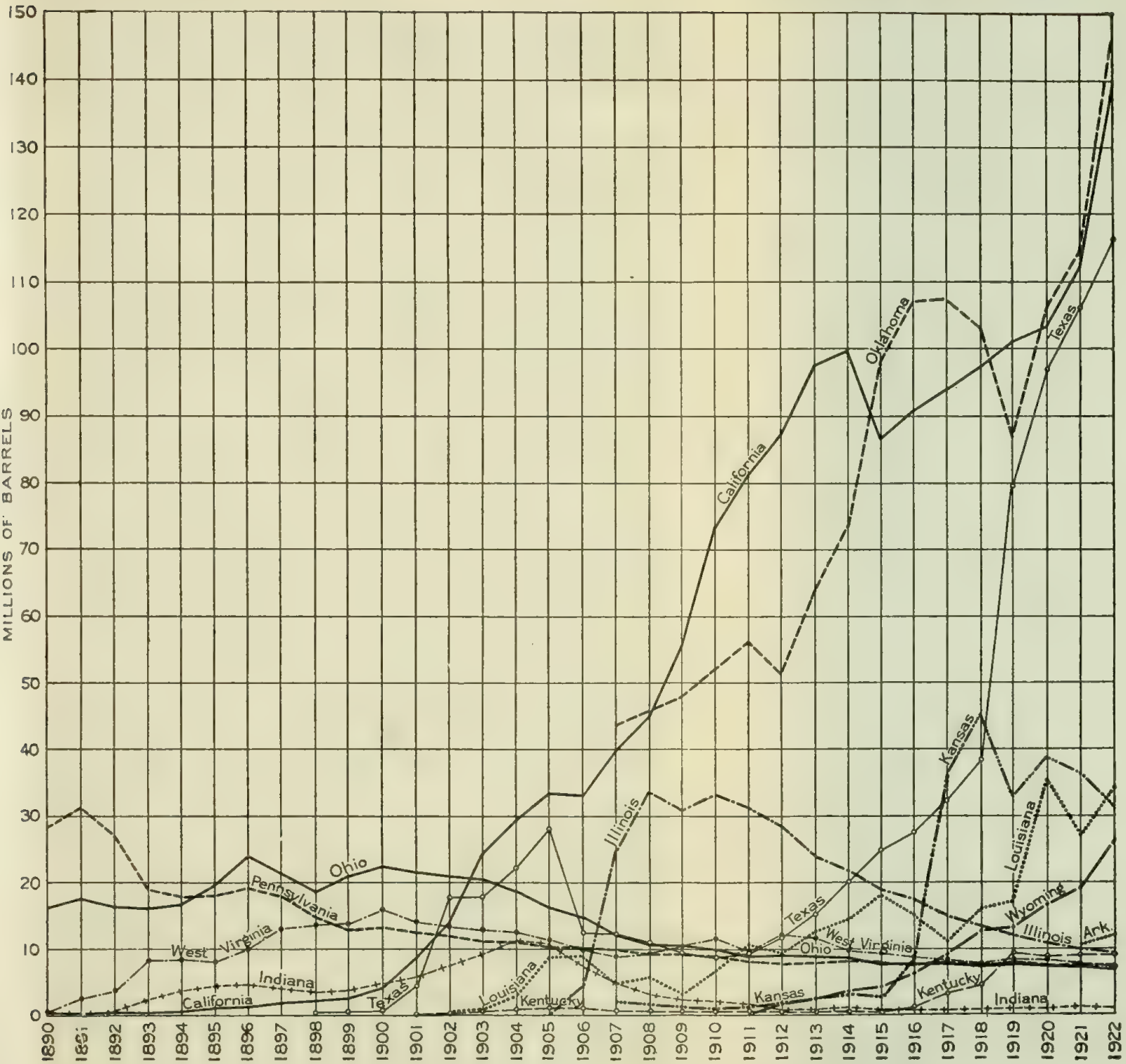
Another important factor is the result of the mode of occurrence of petroleum and the character of ownership of oil lands. If a newly discovered oil pool underlies an area that has been divided into small tracts under different ownership, each of the rival producers endeavors to obtain as quickly as possible as much oil as possible from the same reservoir. These conditions have caused the recent rapid development and resulting overproduction of petroleum in southern California.

SUMMARY OF CHANGES AND DEVELOPMENTS IN THE UNITED STATES.

The production curves for the several States (Pl. I) show the effect of the discovery of new pools and the decline in production when large pools are not brought in. Within the last few years the new pools discovered in California, Oklahoma, Texas, and Arkansas have caused the production of these States to increase greatly, culminating in the unprecedented developments in California. Kansas, which reached its peak in 1918, when the Eldorado pool was at its height, attained a secondary peak in 1920 as a result of developments in Butler, Marion, and Greenwood counties, but the discovery of a few pools since then has not prevented a steady decrease in production. In Louisiana a decline in 1921 followed the falling off of flush production of the Homer field, but in 1922 the yield of the Haynesville pool caused another upward swing in the production curve, which shows a number of ups and downs. The curve for Wyoming shows a continuous ascent due to the discovery of new pools and to the increasing production of the Salt Creek field.

The curves for recent years for the older producing Eastern States, except Kentucky, do not show the variations that are characteristic of the curves of the Western States, in most of which the maximum production has not been reached. The curve for Illinois has persistently declined since 1910, at a much greater rate than the curves


U. S. GEOL
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
MILLIONS OF BARRELS
1890
1891
1892



PRODUCTION OF PETROLEUM IN THE UNITED STATES, BY STATES, 1890–1922.

of the other Eastern States. The curves for Pennsylvania, West Virginia, and Ohio have flattened out remarkably in the last ten years, but the production of New York has increased each year since 1918, not because of the discovery of new pools but because of the successful practice of "flooding," a process to which the homogeneous widespread Bradford sand is particularly well adapted.

In 1922 Oklahoma led all the States in the production of petroleum with a yield of 149,571,000 barrels, an increase of 30 per cent over that in 1921. This increase was due chiefly to flush production in the Burbank, Bristow, Hewitt, Lyons-Quinn, and Tonkawa pools. It has been estimated that more than 24 million barrels of oil was obtained from the Burbank pool during the year. The large production of Oklahoma is due to the sustained yield of its many large and long-lived pools. In January, 1923, the Oklahoma Geological Survey published a list of 243 oil and gas producing areas in the State.

Although California ranked second among the oil-producing States, with an output of 138,468,000 barrels, the most noteworthy feature of the production of petroleum in 1922 in the United States was California's increase of 23 per cent over her output of 1921, foreshadowing her tremendous production in 1923. This increase was due to the development of the Long Beach, Santa Fe Springs, and Huntington Beach pools, in the Los Angeles basin. Oil was obtained from the Huntington Beach pool throughout 1921, but the yield was greatly increased during 1922. Santa Fe Springs and Long Beach began to produce late in 1921 and rapidly increased through each successive month of 1922. During the last six months of the year these three pools produced almost half the entire yield of the State. The reason for the rapid development of these pools far beyond the requirement of the industry lay primarily in the character of the ownership of the land, which was mostly held in small tracts on which many protective offset wells were drilled. Three oil zones are reported in each of these fields, the productive sands are unusually thick, and some of the wells are more than 5,000 feet deep. The quality of the oil from these new pools is the highest in California, the specific gravity averaging not far from 0.876 (30° Baumé). In order to lessen the oversupply a number of wells in the older pools were shut in, especially in the San Joaquin Valley. This caused decreased production in Kern and Fresno counties, but nevertheless by the end of the year the quantity of crude oil held in storage in California was greater than had previously been recorded.

Late in 1922 the surplus supply of high-grade oil in California, coinciding with a decrease in imports of petroleum from Mexico, led to the beginning of shipments of California oil through the Panama Canal to refineries at Gulf coast and Atlantic ports in the United States, the total shipments for the year as reported by the Panama Canal Record amounting to 345,000 long tons. Thus the California petroleum industry was removed from its condition of isolation, and oil from the Pacific coast came into direct competition with Mid-Continent oil at Atlantic coast points.

Texas attained a new high record in 1922, with a yield of 118,684,000 barrels, an increase of 12 per cent over the production in 1921. The Mexia pool, in Limestone County, and Currie, to the northeast, were the most notable new developments in the State. These pools are credited with a yield of approximately 35 million barrels.

The Luling pool was discovered in 1922, but commercial production did not begin until 1923. Other noteworthy new developments were the Mirando, South Electra, and Pioneer pools. The Ranger district continued to decline from its maximum reached in 1919. In the Gulf coast field the greatest increase was in the Orange pool, the output of which rose from 470,000 barrels in 1921 to 5,345,000 barrels in 1922. This pool was opened in 1913 but produced only a small quantity of oil until late in 1921, when drilling to deeper sands resulted in wells of large yield from depths mostly between 3,000 and 4,300 feet. Relatively small increases in production are recorded for Goose Creek, Damon Mound, and Blue Ridge. Decreased yields are recorded for the older salt-dome fields of the Gulf coast, West Columbia, the largest producer, decreasing from 12,081,000 barrels in 1921 to 11,126,000 barrels in 1922. During the year the Big Creek salt dome, in Fort Bend County, was discovered and the presence of oil was proved, but none was sold. This is the first salt-dome pool that has been discovered since 1917, though many hundred wildcat wells have been sunk.

The discovery and development of the Smackover field, in Union and Ouachita counties, Ark., was the most important event of the year 1922 in the North Louisiana-Arkansas district. Attention was directed to this field by a gas well that came in during April and blew out a crater 450 feet in diameter and 50 feet deep. The first oil well in the field was completed on July 31, and by the end of the year the field was credited with a daily average production of more than 90,000 barrels. Many wells in this field came in with an initial production between 5,000 and 10,000 barrels a day, and a few are credited with 30,000 barrels. Both light and heavy oil occur in the Smackover field; the so-called light oil ranges from 23° to 29°, and the heavy oil ranges from 18° to 23.° In the summer of 1923 the heavy oil constituted nearly 90 per cent of the total yield of the field, which by that time had attained a daily average production of about 125,000 barrels. Continued development of the El Dorado pool and the opening of the Stephens pool brought the production of Arkansas for the year up to more than 12 million barrels, an increase of 21 per cent from the production in 1921.

Extensive development of the Haynesville pool, in northern Louisiana, which produced about 20 million barrels, as against 3 million barrels in 1921, is responsible for the State's increased production.

In Kansas production continued to decrease in 1922, the yield of the few small pools opened, principally in Greenwood and Butler counties, failing to counteract the decline in production since the State reached its peak in the development of the Towanda district in 1918.

In the Rocky Mountain field the most far-reaching event of the year was the provision made for the construction of a pipe line from the Salt Creek and Teapot Dome pools to connect with a trunk line in the vicinity of Kansas City, in connection with the opening to exploitation of the Teapot Dome Naval Reserve. Wyoming, with a production of 26,715,000 barrels, increased its yield 38 per cent over that of 1921. In this gain the dominant factor was increased development of the Salt Creek field, the production of which rose from 12,172,000 barrels in 1921 to 19,248.000 barrels in 1922. Smaller

increases are recorded for most of the other pools of the State. Teapot Dome Naval Reserve, No. 3, was leased by the Government in 1922, and about 37,000 barrels was produced in this field during the last four months of the year.

The Cat Creek pool, in Montana, with a yield of 2,333,000 barrels, contributed 95 per cent of the output of the State. The production of the Montana portion of the Elk Basin pool decreased to 46,000 barrels. The Kevin-Sunburst pool, opened in 1922 with a production of 36,000 barrels, is the second largest developed pool in Montana.

The production of oil in Colorado continued to decrease, and for the first time since 1887 this State produced less than 100,000 barrels. It has never been a large producer, however, the maximum output being 824,000 barrels, in 1892.

In the eastern fields the production of petroleum declined during 1922 in all the States except New York and Pennsylvania, and for Pennsylvania the reports show an increase of only 7,000 barrels. The largest losses are recorded in West Virginia, Illinois, and Ohio, where the decreases in production for the year were, respectively, 801,000, 660,000, and 554,000 barrels. A gain of 12,000 barrels in New York marks the fourth successive year of increased production due to the application of "flooding." The discovery of a new pool near Tidioute, Pa., in the midst of an area almost surrounded by old developments dating back to the beginning of the oil industry, caused considerable local interest. Some of the wells are reported to have had an initial daily production of 700 or 800 barrels, but it was soon determined that the pool was of small extent, the oil being confined in a small lens that had been missed in the early drilling.

PRODUCTION.

DOMESTIC PRODUCTION.

The oil-producing States (see fig. 11) fall into three groups, based on the magnitude of their current production. Oklahoma, California, and Texas, each producing more than 100 million barrels a year, far surpass the others. The second group includes Louisiana, Kansas, Wyoming, and Arkansas, each producing from 25 to 36 million barrels; Arkansas, however, did not join this group until 1923. The remaining oil-producing States constitute the third group, in which the annual production in 1922 for each was less than 10 million barrels. Illinois, Kentucky, Pennsylvania, West Virginia, and Ohio produced between 6,500,000 and 9,500,000 barrels, Montana approximately 2,500,000 barrels, and Indiana and New York about 1,000,000 barrels each.

The figures of production given in the following tables were obtained by combining monthly and annual reports to the United States Geological Survey. Monthly reports of companies that operate gathering lines, which show the quantity of petroleum transported from producing properties, constitute the preliminary data published in the Geological Survey's monthly press notice "Statistics of crude petroleum." To these figures, which since 1918 have included between 98 and 99 per cent of the total production, are added, to complete the record, the quantity of petroleum consumed for fuel on the leases and the net change in stocks held on producing properties on the first and last days of the year as reported annually by producers to

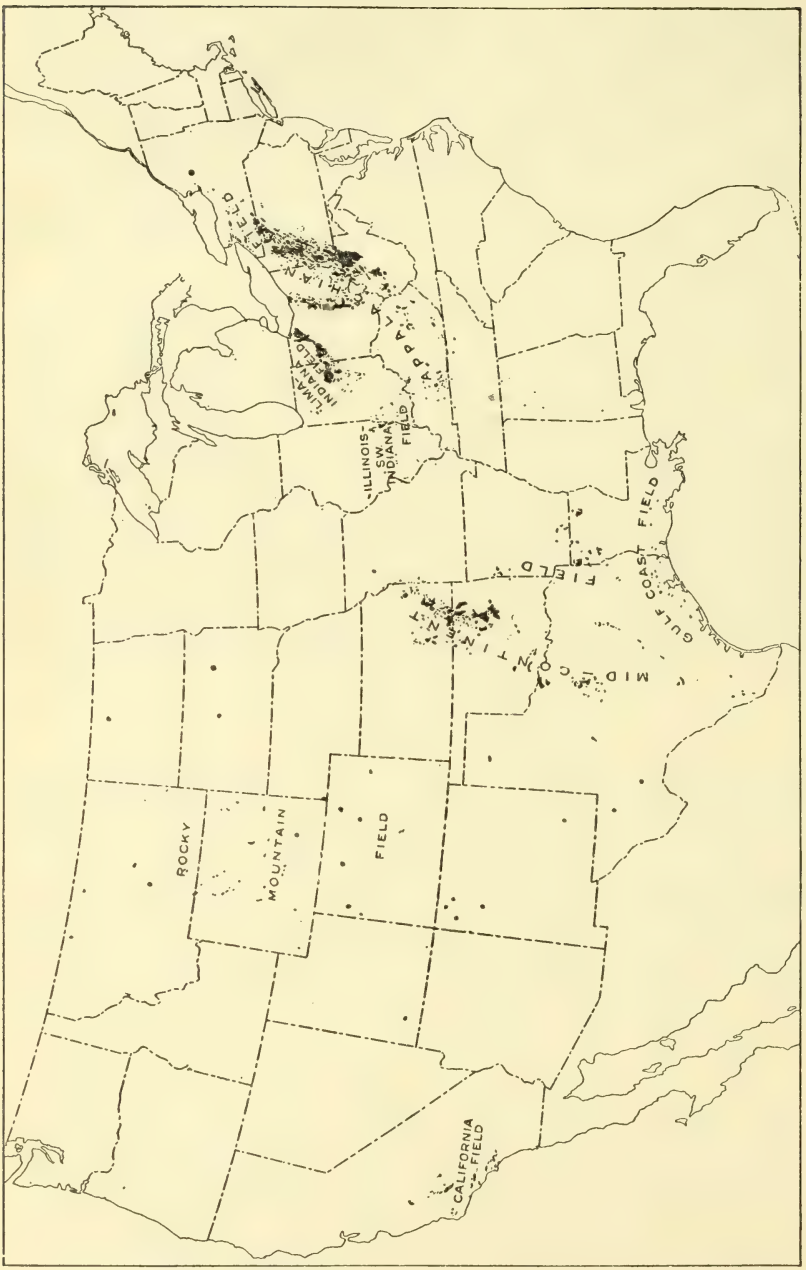


FIGURE 11.—Map of the United States showing oil and gas fields.

the Geological Survey. Prior to 1919 the Geological Survey's figures relating to the production of petroleum included the quantity transported from producing properties and the quantity consumed for fuel on producing properties but did not take into account producers' stocks. In the statistical reports for the years 1914 to 1917 this fact was indicated by the use of the terms "marketed production" and "petroleum marketed." In 1914 and 1915, during the period of flush production of the Cushing field, the estimated actual production was about 25,000,000 barrels greater than was indicated by the official figures.[4]

The degree of detail in which the Geological Survey can present statistics of production is determined by the data supplied by pipe-line companies. Detailed figures by months showing petroleum transported from producing properties can be compiled for isolated pools like those of the Gulf coast field and of northern Louisiana and Wyoming, the records of which are kept separately on the books of the companies. But in States like Oklahoma and Pennsylvania, where the pools are close together and where different pipe-line companies have different boundaries delimiting their field districts, it is not practicable for the Survey to obtain data of production by pools.

[4] U. S. Geol. Survey Mineral Resources for 1914, pt. 2, p. 894, 1915; idem for 1915, pt. 2, p. 563, 1916.

Petroleum produced in the

[Thousands of barrels

Year.	New York.	Pennsylvania.	West Virginia.	Kentucky.	Tennessee.	Ohio.	Indiana.	Illinois.	Kansas.
1859–1875	.....	74,072	.....	.....	.....	.....	.....	.....	.....
1876	.....	8,969	120	.....	.....	32	.....	.....	.....
1877	.....	13,135	172	.....	.....	30	.....	.....	.....
1878	.....	15,164	180	.....	.....	38	.....	.....	.....
1879	.....	19,685	180	.....	.....	29	.....	.....	.....
1880	(a)	a 26,028	179	.....	.....	39	.....	.....	.....
1881	(a)	a 27,376	151	.....	.....	34	.....	.....	.....
1882	6,685	23,368	128	.....	.....	40	.....	.....	.....
1883	4,004	19,125	126	b 5	(b)	47	.....	.....	.....
1884	3,231	20,541	90	b 4	(b)	90	.....	.....	.....
1885	2,658	18,118	91	b 5	(b)	662	.....	.....	.....
1886	2,151	23,647	102	b 5	(b)	1,783	.....	.....	.....
1887	2,075	20,281	145	b 5	(b)	5,023	.....	.....	.....
1888	(a)	a 16,489	119	b 5	(b)	10,011	.....	.....	.....
1889	1,897	19,591	544	b 5	(b)	12,472	33	1.5	0.5
1890	(a)	a 28,458	493	b 6	(b)	16,125	64	1	1
1891	1,585	31,424	2,406	b 9	(b)	17,740	137	.5	1.5
1892	1,273	27,149	3,810	b 7	(b)	16,363	698	1	5
1893	1,032	19,283	8,446	b 3	(b)	16,249	2,335	1	18
1894	942	18,078	8,577	b 2	(b)	16,792	3,689	(c)	40
1895	913	18,231	8,120	b 2	(b)	19,545	4,386	(c)	44
1896	1,205	19,379	10,020	b 2	(b)	23,941	4,681	(c)	114
1897	1,279	17,983	13,090	(c)	(b)	21,561	4,122	1	81
1898	1,205	14,743	13,615	b 6	(b)	18,739	3,731	(c)	72
1899	1,321	13,054	13,911	b 18	(b)	21,142	3,848	(c)	70
1900	1,301	14,258	16,196	b 62	(b)	22,363	4,874	(c)	75
1901	1,207	12,625	14,177	b 137	(b)	21,648	5,757	(c)	179
1902	1,120	12,064	13,513	b 185	(b)	21,014	7,481	(c)	332
1903	1,163	11,355	12,900	b 554	(b)	20,480	9,186	.....	932
1904	1,113	11,126	12,645	b 998	(b)	18,877	11,339	.....	4,251
1905	1,118	10,437	11,578	b 1,217	(b)	16,347	10,964	181	f 12,014
1906	1,243	10,257	10,121	b 1,214	(b)	14,788	7,674	4,397	f 21,718
1907	1,212	10,000	9,095	b 821	(b)	12,207	5,128	24,282	2,410
1908	1,160	9,424	9,523	728	.....	10,859	3,283	33,686	1,801
1909	1,135	9,209	10,745	639	.....	10,633	2,296	30,898	1,264
1910	1,054	8,795	11,753	469	.....	9,916	2,160	33,143	1,128
1911	953	8,248	9,796	472	.....	8,817	1,695	31,317	1,279
1912	874	7,838	12,129	484	.....	8,969	970	28,602	1,593
1913	948	7,917	11,567	525	.....	8,781	956	23,894	2,375
1914	939	8,170	9,680	503	.....	8,536	1,336	21,920	3,104
1915	888	7,838	9,265	437	.....	7,825	876	19,042	2,823
1916	874	7,593	8,731	1,202	1	7,744	769	17,714	8,738
1917	880	7,733	8,379	3,088	12	7,751	760	15,777	30,536
1918	809	7,408	7,867	4,368	8	7,285	878	13,366	45,451
1919	851	8,137	8,327	9,278	15	7,736	972	11,960	33,048
1920	906	7,438	8,249	8,738	14	7,400	945	10,774	39,005
1921	988	7,418	7,822	9,013	12	7,335	1,158	10,043	36,456
1922	1,000	7,425	7,021	8,973.2	9.8	6,781	1,087	9,383	31,766
	m57,192	m765,174	325,894	54,194.2	71.8	492,619	110,268	340,385	288,725
Percentage of total production	0.9	11.8	5.0	0.8	.....	7.6	1.7	5.3	4.5

a New York included with Pennsylvania.
b Tennessee included with Kentucky.
c Less than 500 barrels. See Mineral Resources, 1916, pt. 2, pp. 684–685.
d Missouri, and less than 500 barrels.
e Michigan and Missouri.
f Oklahoma included with Kansas.
g Michigan, Missouri, and Utah.

United States, 1859–1922.

of 42 U. S. gallons.]

Oklahoma.	Arkansas.	Louisiana.	Texas.	Montana.	Wyoming.	Colorado.	California.	Other.	United States.	Value at wells (thousands of dollars).	Year.
.....	.....	.....	.....	.....	.....	.....	.....	.....	74,072	215,741	1859–1873
.....	.....	.....	.....	.....	.....	.....	12	.....	9,133	22,983	1874
.....	.....	.....	.....	.....	.....	.....	13	.....	13,350	31,789	1875
.....	.....	.....	.....	.....	.....	.....	15	.....	15,397	35,046	1876
.....	.....	.....	.....	.....	.....	.....	20	.....	19,914	17,211	1879
.....	.....	.....	.....	.....	.....	.....	40	.....	26,286	24,601	1880
.....	.....	.....	.....	.....	.....	.....	100	.....	27,661	25,448	1881
.....	.....	.....	.....	.....	.....	.....	129	.....	30,350	28,631	1882
.....	.....	.....	.....	.....	.....	.....	143	.....	23,450	25,790	1883
.....	.....	.....	.....	.....	.....	.....	202	.....	24,218	20,596	1884
.....	.....	.....	.....	.....	.....	.....	325	.....	21,859	19,198	1885
.....	.....	.....	.....	.....	.....	.....	377	.....	28,065	19,996	1886
.....	.....	.....	.....	.....	.....	76	678	.....	28,288	18,877	1887
.....	.....	.....	.....	.....	.....	208	690	.....	27,612	17,048	1888
.....	.....	.....	(c)	.....	.....	317	303	(d)	35,164	20,064	1889
.....	.....	.....	(c)	.....	.....	369	307	(d)	45,824	35,365	1890
(c)	.....	.....	(c)	.....	.....	666	324	(d)	54,293	30,527	1891
(c)	.....	.....	(c)	.....	.....	824	385	(d)	50,515	25,907	1892
(c)	.....	.....	(c)	.....	.....	504	470	(d)	48,431	28,950	1893
(c)	.....	.....	(c)	.....	2	516	706	(d)	49,344	35,522	1894
(c)	.....	.....	(c)	.....	4	438	1,209	(d)	52,892	57,632	1895
(c)	.....	.....	1	.....	3	361	1,253	(d)	60,960	58,519	1896
1	.....	.....	66	.....	4	385	1,903	(d)	60,476	40,874	1897
.....	.....	.....	546	.....	6	444	2,257	(d)	55,364	44,193	1898
.....	.....	.....	669	.....	6	390	2,642	(d)	57,071	64,604	1899
6	.....	.....	836	.....	6	317	4,325	(e) 2	63,621	75,989	1900
10	.....	.....	4,394	.....	5	461	8,787	(e) 2	69,389	66,417	1901
37	.....	549	18,084	.....	6	397	13,984	(e) 1	88,767	71,179	1902
139	.....	918	17,956	.....	9	484	24,382	(e) 3	100,461	94,804	1903
1,367	.....	2,959	22,241	.....	12	501	29,649	(e) 3	117,081	101,175	1904
(f)	.....	8,910	28,136	.....	8	376	33,428	(e) 3	134,717	84,157	1905
(f)	.....	9,077	12,568	.....	7	328	33,099	(e) 3	126,494	92,445	1906
43,524	.....	5,000	12,323	.....	9	332	39,748	(g) 4	166,095	120,107	1907
45,799	.....	5,789	11,207	.....	18	380	44,855	(g) 15	178,527	129,079	1908
47,859	.....	3,060	9,534	.....	20	311	55,472	(g) 6	183,171	128,329	1909
52,029	.....	6,841	8,899	.....	115	240	73,011	(g) 4	209,557	127,900	1910
56,069	.....	10,721	9,526	.....	187	227	81,134	(g) 8	220,449	134,045	1911
51,427	.....	9,263	11,735	.....	1,572	206	87,239	(h) 4	222,955	164,213	1912
63,579	.....	12,499	15,010	.....	2,407	189	97,788	(i) 11	248,440	237,121	1913
78,632	.....	14,309	20,068	.....	3,560	223	99,775	(j) 8	265,763	214,125	1914
97,915	.....	18,192	24,943	.....	4,246	208	86,592	(j) 14	281,104	179,463	1915
107,072	.....	15,248	27,645	45	6,234	197	90,952	(j) 8	300,767	330,000	1916
107,508	.....	11,392	32,413	100	8,978	121	93,878	(k) 10	335,316	522,635	1917
103,347	.....	16,043	38,750	69	12,596	143	97,532	(k) 8	355,928	703,944	1918
86,911	.....	17,188	79,366	90	13,172	121	101,182	(i) 12	378,367	760,256	1919
106,206	.....	35,714	96,868	340	16,831	111	103,377	(k) 13	442,929	1,360,745	1920
114,634	10,473	27,103	106,166	1,509	19,333	108	112,600	(l) 12	472,183	814,745	1921
149,571	12,712	35,376	118,684	2,449	26,715	97	138,468	(l) 13	557,531	895,111	1922
1,308,642	23,185	266,151	728,634	4,602	116,071	11,756	1,565,851	187	6,459,582	8,359,734	
20.3	0.4	4.1	11.3	0.1	1.8	0.2	24.2	.....	100.00	.....	

h Alaska and Michigan.
i Alaska, Michigan, Missouri, and New Mexico.
j Alaska, Michigan, and Missouri.
k Alaska, Arkansas, Missouri, New Mexico, and Utah.
l Alaska, Missouri, and New Mexico.
m Four years' production in New York included with Pennsylvania.

Petroleum produced in the United States, 1921–1922, by fields.

[Thousands of barrels of 42 U. S. gallons.]

Field.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year.	Value at wells (thousands of dollars).
1921.														
Appalachian	2,517	2,415	2,750	2,612	2,778	2,508	2,472	2,664	2,441	2,397	2,386	2,511	30,451	87,896
Lima-Indiana	209	197	215	205	215	216	194	206	193	188	173	193	2,404	5,423
Illinois and southwestern Indiana	923	855	1,039	841	944	903	882	924	879	960	907	877	10,934	22,486
Mid-Continent	19,985	18,521	21,748	21,470	22,862	22,217	22,672	22,658	20,856	20,624	21,216	23,632	258,461	426,720
Gulf coast	2,954	2,891	3,332	3,094	3,018	2,780	2,900	3,199	3,107	3,044	3,109	2,943	36,371	43,037
Rocky Mountain	1,563	1,632	1,737	2,033	2,121	1,995	1,285	1,617	1,525	1,661	1,669	2,112	20,950	26,033
California	9,986	9,012	10,283	9,977	10,250	9,928	10,055	9,840	7,761	6,957	8,647	9,904	112,600	203,138
Other	1	1	1	1	1	1	1	1	1	1	1	1	12	12
United States	38,138	35,524	41,105	40,233	42,189	40,548	40,461	41,109	36,763	35,832	38,108	42,173	472,183	814,745
1922.														
Appalachian	2,232	2,267	2,548	2,386	2,527	2,596	2,441	2,566	2,421	2,491	2,371	2,334	29,180	80,448
Lima-Indiana	164	172	198	183	204	206	197	202	189	199	179	176	2,269	5,063
Illinois and southwestern Indiana	996	779	945	746	909	864	844	887	823	844	801	793	10,231	21,018
Mid-Continent	25,521	24,516	28,231	26,524	26,711	26,298	26,690	26,085	24,727	25,360	24,651	25,678	310,992	532,738
Gulf coast	3,274	2,923	2,982	2,996	3,151	3,000	2,978	3,110	3,047	3,295	3,152	3,209	37,117	44,313
Rocky Mountain	1,839	1,657	2,074	2,210	2,483	2,519	2,492	2,461	2,497	2,916	2,957	3,156	29,261	38,117
California	9,669	8,999	10,209	10,121	11,016	10,603	11,491	11,747	12,100	13,304	13,915	15,294	138,468	173,381
Other	1	1	1	1	1	1	1	1	1	1	1	2	13	33
United States	43,696	41,314	47,188	45,167	47,002	46,087	47,134	47,059	45,805	48,410	48,027	50,642	557,531	895,111

Petroleum produced in the United States in 1921–1922, by States.

[Thousands of barrels of 42 U. S. gallons.]

State.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year.	Value at wells (thousands of dollars).
1921.														
Arkansas	(a)	(a)	38	328	578	908	1,429	1,929	1,428	1,329	1,278	1,228	10,473	12,746
California	9,986	9,012	10,283	9,977	10,250	9,928	10,055	9,840	7,761	6,957	8,647	9,904	[b] 112,600	[b] 203,138
Colorado	9	9	10	10	10	9	8	9	9	8	9	8	108	132
Illinois	852	785	962	765	863	823	805	846	806	890	837	809	10,043	20,632
Indiana:														
Southwestern	71	70	77	76	81	80	77	78	73	70	70	68	891	1,854
Northeastern	23	22	23	26	25	25	21	23	21	22	16	20	267	560
Total Indiana	94	92	100	102	106	105	98	101	94	92	86	88	1,158	2,414
Kansas	2,387	2,495	3,105	3,318	3,525	3,490	3,438	3,351	3,023	2,844	2,744	2,736	36,456	68,694
Kentucky	749	699	775	773	832	735	712	792	735	721	723	767	9,013	16,736
Louisiana:														
Northern	2,564	2,201	2,138	1,991	2,423	2,161	2,030	1,820	1,857	1,851	1,789	2,348	25,173	40,235
Coastal	173	171	185	172	178	167	172	155	146	143	131	137	1,930	2,234
Total Louisiana	2,737	2,372	2,323	2,163	2,601	2,328	2,202	1,975	2,003	1,994	1,920	2,485	27,103	42,469
Montana	82	118	103	102	124	120	123	126	144	161	148	158	1,509	2,373
New York	85	66	87	84	105	78	80	87	89	78	68	81	988	3,262
Ohio:														
Central and eastern	434	427	470	443	467	464	403	445	417	405	409	414	5,198	16,649
Northwestern	186	175	192	179	190	191	173	183	172	165	157	173	2,137	4,863
Total Ohio	620	602	662	622	657	655	576	628	589	571	566	587	7,335	21,512
Oklahoma	8,544	7,987	9,675	9,586	10,038	9,747	10,182	10,223	9,769	9,684	9,428	9,771	114,634	183,185
Pennsylvania	618	602	673	635	676	614	565	673	601	579	593	589	7,418	24,746
Tennessee	1	1	1	1	1	1	1	1	1	1	1	1	12	21
Texas:														
Central and northern	6,490	5,838	6,792	6,247	6,298	5,911	5,593	5,335	4,779	4,916	5,977	7,549	71,725	121,860
Coastal	2,781	2,720	3,147	2,922	2,840	2,613	2,728	3,044	2,961	2,901	2,978	2,806	34,441	40,803
Total Texas	9,271	8,558	9,939	9,169	9,138	8,524	8,321	8,379	7,740	7,817	8,955	10,355	106,166	162,663
West Virginia	630	620	744	676	697	616	711	666	598	613	592	659	7,822	26,482
Wyoming	1,472	1,505	1,624	1,921	1,987	1,866	1,154	1,482	1,372	1,492	1,512	1,946	19,333	23,528
Other [c]	1	1	1	1	1	1	1	1	1	1	1	1	12	12
United States	38,138	35,524	41,105	40,233	42,189	40,548	40,461	41,109	36,763	35,832	38,108	42,173	472,183	814,745

[a] Not available. Figures for subsequent months represesent oil transported from producing properties plus adjustment for oil consumed for fuel on the leases and for producers' storage; for early months of the year figures are short of actual production.

[b] California State Mining Bureau. Monthly figures for California prorated on basis of average figures reported by Standard Oil Co. and Independent Oil Producers' Agency.

[c] Alaska, Missouri, and New Mexico.

Petroleum produced in the United States in 1921–1922, by States—Continued.

[Thousands of barrels of 42 U. S. gallons.]

State.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year.	Value at wells (thousands of dollars).
1922.														
Arkansas	1,152	1,032	1,087	1,135	1,108	994	973	881	739	907	1,071	1,633	12,712	20,416
California	9,669	8,999	10,209	10,121	11,016	10,603	11,491	11,747	12,100	13,304	13,915	15,294	[d]138,468	[d]173,381
Colorado	7.5	7.4	7.6	7.8	9	9.6	7.6	8.2	8.5	8.7	7.6	7.5	97	114
Illinois	926	716	880	678	832	792	770	811	753	770	729	726	9,383	19,291
Indiana:														
Southwestern	70	63	65	68	77	72	74	76	70	74	72	67	848	1,727
Northeastern	18	18	21	18	22	24	21	21	19	21	18	18	239	498
Total Indiana	88	81	86	86	99	96	95	97	89	95	90	85	1,087	2,225
Kansas	2,698	2,471	2,763	2,632	2,793	2,802	2,624	2,749	2,620	2,629	2,537	2,448	31,766	56,131
Kentucky	700	706.4	779.8	742.2	801	762.1	781.7	791.4	745	762.2	721.4	680	8,973.2	17,758
Louisiana:														
Northern	2,864	2,941	3,950	2,602	2,589	2,728	2,824	2,806	2,743	2,727	2,467	2,388	33,629	50,982
Coastal	143	131	146	132	131	126	141	149	149	160	163	[e]176	1,747	2,187
Total Louisiana	3,007	3,072	4,096	2,734	2,720	2,854	2,965	2,955	2,892	2,887	2,630	2,564	35,376	53,169
Montana	151	132	166	155	151	195	229	264	256	261	247	242	2,449	4,048
New York	77	73	80	78	95	85	85	83	94	85	85	80	1,000	3,144
Ohio:														
Central and eastern	365	364	410	375	422	408	389	418	396	415	393	396	4,751	12,804
Northwestern	146	154	177	165	182	182	176	181	170	178	161	158	2,030	4,565
Total Ohio	511	518	587	540	604	590	565	599	566	593	554	554	6,781	17,369
Oklahoma	10,241	10,252	12,208	12,265	13,218	13,171	13,585	13,118	12,527	12,897	12,724	13,365	149,571	258,160
Pennsylvania	540	558	629	597	660	638	620	667	628	662	629	597	7,425	23,834
Tennessee	1	.6	1.2	.8	1	.9	.3	.6	1	.8	.6	1	9.8	17
Texas:														
Central and northern	8,566	7,820	8,223	7,890	7,003	6,603	6,684	6,531	6,098	6,200	5,852	5,844	83,314	147,049
Coastal	3,131	2,792	2,836	2,864	3,020	2,874	2,837	2,961	2,898	3,135	2,989	3,033	35,370	42,126
Total Texas	11,697	10,612	11,059	10,754	10,023	9,477	9,521	9,492	8,996	9,335	8,841	8,877	118,684	189,175
West Virginia	549	565	648	593	548	702	565	606	557	566	542	580	7,021	22,891
Wyoming	1,680.5	1,517.6	1,900.4	2,047.2	2,323	2,314.4	2,255.4	2,188.8	2,232.5	2,646.3	2,702.4	2,906.5	26,715	33,955
Other [c]	1	1	1	1	1	1	1	1	1	1	1	2	13	33
United States	43,696	41,314	47,188	45,167	47,002	46,087	47,134	47,059	45,805	48,410	48,027	50,642	557,531	895,111

[c] Alaska, Missouri, and New Mexico.

[d] Total annual production of "clean oil," from California State Mining Bureau. Monthly figures for California prorated on basis of monthly reports by American Petroleum Institute.

Petroleum produced in Kentucky and Pennsylvania, 1921–1922, in barrels, by counties.

Kentucky.[a]			Pennsylvania.[b]		
County.	1921	1922	County.	1921	1922
Allen	590,644	641,556	Allegheny	598,480	574,552
Barren	31,428	68,702	Armstrong	24,807	24,788
Bath	17,168	17,622	Beaver	125,795	117,914
Boyd	1,084	1,252	Butler	874,878	825,366
Cumberland		11,806	Clarion	230,044	212,206
Estill	840,811	729,393	Crawford	48,298	48,406
Floyd	3,670	4,834	Elk	116,432	109,244
Hancock		2,625	Forest	96,033	87,226
Jackson	2,123	2,299	Greene	413,163	317,343
Johnson	315,568	666,758	Jefferson	13,210	10,036
Knott	2,953	3,113	Lawrence	31,736	31,825
Lawrence	345,162	402,196	McKean	2,311,662	2,466,723
Lee	4,434,506	3,429,481	Mercer	14,795	12,954
Lincoln	144	633	Potter	13,612	13,375
Logan	1,952	3,766	Tioga	10,095	8,779
Magoffin	617,703	1,234,373	Venango	1,454,528	1,360,093
Martin	228	190	Warren	342,640	516,781
McCreary	6,867	6,399	Washington	531,117	499,893
Menifee	52,035	13,297	Westmoreland	150	233
Monroe		68		7,251,475	7,237,737
Morgan	12,636	11,126			
Ohio		1,266	To equal Geological Survey figures	+166,525	+187,263
Powell	246,952	207,124		7,418,000	7,425,000
Russell		2,235			
Simpson	9,318	62,810			
Warren	1,109,307	1,112,245			
Wayne	351,527	189,615			
Whitley	1,303	265			
Wolfe	95,757	86,651			
	9,090,846	8,913,700			
To equal Geological Survey figures	−77,846	+59,500			
	9,013,000	8,973,200			

[a] Reports to Kentucky State Tax Commission (figures for 1921 compiled by Kentucky Oil Men's Association).
[b] Department of Internal Affairs, Pennsylvania.

Petroleum produced in coastal Texas, 1901–1922, by districts.

[Thousands of barrels of 42 U. S. gallons.]

Year.	Batson.	Blue Ridge.	Damon Mound.	Dayton.	Goose Creek.	Hull.	Humble.	Markham.
1901								
1902								
1903	5							
1904	10,905							
1905	3,775			60			15,594	
1906	2,290			93			3,571	
1907	2,164			108			2,930	
1908	1,594			40	(a)		3,778	62
1909	1,206			18	(a)		3,237	28
1910	1,114			10	(a)		2,496	455
1911	1,023			4	(a)		2,426	560
1912	845			12	44		1,830	611
1913	741			13	250		1,505	293
1914	776			19	135		2,799	163
1915	704			10	119		11,062	137
1916	745			9	397		10,926	157
1917	693		[b] 124	10	7,300		7,390	127
1918	635		[b] 283	9	8,944	245	6,555	65
1919	560		191	8	5,770	1,273	3,706	54
1920	527	92	379	17	4,476	3,909	3,607	57
1921	495	326	666	40	4,640	8,150	3,004	49
1922	434	349	754	29	4,766	6,546	2,284	35

[a] Included under "Other." [b] Damon Mound includes West Columbia.

Petroleum produced in coastal, Texas, 1901–1922, by districts—Continued.

[Thousands of barrels of 42 U. S. gallons.]

Year.	Orange.	Pierce Junction.	Saratoga.	Sourlake.	Spindletop.	West Columbia.	Other.	Total.
1901					3,593			3,593
1902			(c)	c 45	17,421			17,466
1903			(c)	c 8,848	8,601			17,454
1904			735	6,442	3,438		152	21,672
1905			3,125	3,362	1,653		47	27,616
1906			2,182	2,156	1,077		81	11,450
1907			2,131	2,354	1,700		23	11,410
1908			1,635	1,595	1,747		32	10,483
1909			1,183	1,704	1,388		88	8,852
1910			1,024	1,519	1,182		130	7,930
1911			926	1,365	966		5	7,275
1912			1,117	1,175	823		3	6,460
1913	18		938	1,348	716		3	5,825
1914	43		890	5,209	580		3	10,617
1915	22		864	4,115	388		48	17,469
1916	18		781	4,923	341		45	18,342
1917	7		683	4,763	380	(b)	36	21,513
1918			722	3,408	557	(b)	47	21,470
1919			737	2,709	407	5,611	31	21,057
1920			849	2,024	322	9,459	17	25,735
1921	470	1,239	1,129	1,802	344	12,081	6	34,441
1922	5,345	1,020	713	1,675	289	11,126	5	35,370

b Damon Mound includes West Columbia. c Sourlake includes Saratoga.

Petroleum produced in coastal Texas, 1921–1922, by districts and months.

[Thousands of barrels of 42 U. S. gallons.]

District.	Petroleum transported from producing properties.													Oil consumed on leases plus net change in producers' stocks, Jan. 1–Dec. 31.	Production.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year.		
1921.															
Batson	47	42	47	42	42	41	37	38	39	28	41	36	480	15	495
Blue Ridge	20	23	44	31	28	27	19	23	14	16	16	13	274	52	326
Damon Mound	.....	71	.....	37	94	91	71	64	70	68	75	4	645	21	666
Dayton	4	3	3	4	3	3	3	2	4	2	3	2	36	4	40
Goose Creek	371	405	383	427	498	348	342	332	360	318	331	313	4,428	212	4,640
Hull	743	881	1,007	793	652	561	559	658	612	552	452	443	7,913	237	8,150
Humble	247	212	246	254	230	216	248	291	240	228	209	203	2,824	180	3,004
Markham	8	5	6	4	3	2	3	4	3	3	2	2	45	4	49
Orange	.....	.....	.....	.....	17	12	4	15	10	39	103	207	407	63	470
Pierce Junction	.....	.....	.....	.....	.....	.....	41	108	240	208	324	265	1,186	53	1,239
Saratoga	95	90	90	81	81	73	74	63	65	60	63	59	894	235	1,129
Sourlake	150	133	145	155	142	132	139	183	131	123	122	127	1,682	120	1,802
Spindletop	32	28	35	33	29	28	29	29	25	26	23	24	341	3	344
West Columbia	893	673	970	896	850	914	988	1,063	983	1,059	1,049	937	11,275	806	12,081
Other	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	6
	2,610	2,566	2,976	2,757	2,669	2,448	2,557	2,873	2,796	2,730	2,813	2,635	32,430	2,011	34,441
1922.															
Batson	40	36	34	38	37	36	34	35	32	31	32	28	413	21	434
Blue Ridge	25	14	7	6	21	10	33	40	23	57	23	24	283	66	349
Damon Mound	59	52	55	59	71	59	65	71	68	66	56	67	748	6	754
Dayton	3	2	2	2	2	2	3	2	3	3	2	3	29	.....	29
Goose Creek	325	251	273	357	391	386	311	382	407	410	440	551	4,484	282	4,766
Hull	422	380	384	448	606	470	540	527	577	721	752	709	6,536	10	6,546
Humble	185	162	177	170	174	169	176	174	153	199	183	190	2,112	172	2,284
Markham	3	2	4	3	4	2	4	3	3	2	3	2	35	.....	35
Orange	462	225	453	474	403	488	462	478	421	454	371	351	5,042	303	5,345
Pierce Junction	167	159	130	73	75	73	58	36	37	36	37	36	917	103	1,020
Saratoga	57	57	61	50	57	49	51	50	52	54	52	54	644	69	713
Sourlake	136	118	120	133	138	131	130	129	128	139	136	136	1,574	101	1,675
Spindletop	24	20	25	24	25	25	25	24	23	23	24	26	288	1	289
West Columbia	1,090	1,194	978	898	883	846	812	877	842	807	750	723	10,700	426	11,126
Other	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	5
	2,998	2,672	2,703	2,735	2,887	2,746	2,704	2,828	2,769	3,002	2,861	2,900	33,805	1,565	35,370

Petroleum produced in Mexia field, Tex., 1921–1922, by months.

[Thousands of barrels of 42 U. S. gallons.]

Year.	Petroleum transported from producing properties.													Oil consumed on leases plus net change in producers' stocks, Jan. 1–Dec. 31.	Production.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year.		
1921	.....	.....	.....	3	65	113	1	.....	2	311	1,541	3,059	5,095	802	5,897
1922	4,356	4,086	4,293	4,167	2,711	2,207	2,067	1,897	1,768	1,850	1,710	1,702	32,814	1,014	33,828

Petroleum produced in coastal Louisiana, 1909–1922, by districts.

[Thousands of barrels of 42 U. S. gallons.]

Year.	Anse la Butte.	Edgerley.	Jennings.	Vinton.	Other.	Total.
1909	38	.....	1,967	.....	26	2,031
1910	44	.....	1,625	27	55	1,751
1911	63	.....	1,180	2,454	28	3,725
1912	25	.....	1,106	932	22	2,085
1913	6	.....	791	1,889	31	2,717
1914	19	586	412	1,465	19	2,501
1915	21	1,403	435	1,234	17	3,110
1916	13	1,252	517	1,640	4	3,426
1917	5	806	399	1,595	25	2,830
1918	[a] 3	512	369	1,839	15	2,738
1919	.....	361	347	1,592	9	2,309
1920	.....	379	232	1,333	3	1,947
1921	47	250	254	1,379	.....	1,930
1922	36	125	191	1,395	.....	1,747

[a] Estimated.

Petroleum produced in coastal Louisiana, 1921–1922, by districts and months.

[Thousands of barrels of 42 U. S. gallons.]

District.	Petroleum transported from producing properties.													Oil consumed on leases plus net change in producers' stocks, Jan. 1–Dec. 31.	Production.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year.		
1921.															
Anse la Butte	.....	.....	3	7	8	4	5	5	2	1	1	3	39	8	47
Edgerley	26	26	27	20	17	15	17	12	15	11	13	10	209	41	250
Jennings	22	21	20	20	19	17	21	16	15	16	16	13	216	38	254
Vinton	108	109	118	109	116	114	112	105	98	98	85	94	1,266	113	1,379
	156	156	168	156	160	150	155	138	130	126	115	120	1,730	200	1,930
1922.															
Anse la Butte	2	2	2	3	2	2	3	3	3	3	2	3	30	6	36
Edgerley	8	6	9	8	6	5	6	9	6	7	6	10	86	39	125
Jennings	17	13	15	13	13	15	17	14	14	16	12	15	174	17	191
Vinton	101	96	104	93	94	89	99	107	112	117	128	133	1,273	122	1,395
	128	117	130	117	115	111	125	133	135	143	148	161	1,563	184	1,747

Petroleum produced in northern Louisiana, 1909–1922, by districts.

[Thousands of barrels of 42 U. S. gallons.]

Year.	Bellevue.	Caddo.	De Soto.	Haynesville.	Homer.	Red River (Bull Bayou, Crichton).	Other.	Total.
1909	.....	1,029	.....	.....	.....	.....	.....	1,029
1910	.....	5,090	.....	.....	.....	.....	.....	5,090
1911	.....	6,996	.....	.....	.....	.....	.....	6,996
1912	.....	7,178	.....	.....	.....	.....	.....	7,178
1913	.....	9,782	.....	.....	.....	.....	.....	9,782
1914	.....	7,572	3,834	.....	.....	402	.....	11,808
1915	.....	6,472	1,797	.....	.....	6,802	11	15,082
1916	.....	5,464	1,657	.....	.....	4,691	10	11,822
1917	.....	5,483	1,371	.....	.....	1,665	43	8,562
1918	.....	11,144	1,066	.....	.....	1,046	49	13,305
1919	.....	[a] 8,700	[a] 1,200	.....	[a] 2,000	[a] 2,900	79	14,879
1920	.....	6,336	(b)	.....	21,508	[b] 5,923	.....	33,767
1921	.....	5,342	719	3,161	13,030	2,844	77	25,173
1922	1,050	4,498	531	19,939	5,673	1,778	160	33,629

[a] Estimated. [b] De Soto included under Red River.

Petroleum produced in northern Louisiana, 1921–1922, by districts and months.

[Thousands of barrels of 42 U. S. gallons.]

District.	Petroleum transported from producing properties.												Oil consumed on leases plus net change in producers' stocks, Jan. 1–Dec. 31.	Production.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year.	
1921.														
Caddo	528	483	515	460	482	444	427	390	412	382	366	385	5,274	68	5,342
De Soto	62	61	68	72	66	60	62	58	57	55	52	51	724	−5	719
Haynesville	.....	.....	.....	.....	74	218	190	250	313	417	510	1,074	3,046	115	3,161
Homer	1,625	1,348	1,204	1,143	1,503	1,172	1,099	876	837	761	638	617	12,823	207	13,030
Red River (Bull Bayou, Crichton)	308	269	303	269	263	233	217	210	202	202	189	187	2,852	−8	2,844
Other	8	11	15	15	3	3	3	5	4	3	2	2	74	3	77
	2,531	2,172	2,105	1,959	2,391	2,130	1,998	1,789	1,825	1,820	1,757	2,316	24,793	380	25,173
1922.															
Bellevue	.....	11	63	49	48	57	92	120	127	121	106	119	913	137	1,050
Caddo	397	372	404	344	395	387	378	359	332	340	370	383	4,461	37	4,498
De Soto	48	41	50	46	46	44	44	43	38	44	38	44	526	5	531
Haynesville	1,565	1,865	2,636	1,306	1,386	1,528	1,616	1,625	1,629	1,598	1,373	1,259	19,386	553	19,939
Homer	593	412	541	614	473	493	470	439	405	411	375	376	5,602	71	5,673
Red River (Bull Bayou, Crichton)	175	158	165	142	131	114	117	116	112	116	110	109	1,565	213	1,778
Other	.....	4	4	17	23	21	20	17	16	10	11	12	155	5	160
	2,778	2,863	3,863	2,518	2,502	2,644	2,737	2,719	2,659	2,640	2,383	2,302	32,608	1,021	33,629

Petroleum transported from producing properties in Osage County, Okla., 1919–1922, by months.[a]

[Thousands of barrels of 42 U. S. gallons.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	The year.
1919	1,040	933	1,102	1,083	1,213	1,207	1,281	1,322	1,356	1,371	1,273	1,273	14,454
1920	1,329	1,324	1,525	1,544	1,699	1,781	1,931	1,940	1,776	1,871	1,740	1,547	20,007
1921	1,383	1,452	1,782	1,677	1,764	1,723	1,746	1,914	1,901	1,976	2,122	2,152	21,592
1922	2,290	2,289	2,729	2,936	3,347	3,440	3,503	3,378	3,327	3,590	3,651	3,736	38,216

[a] Figures furnished by Osage Indian Agency.

Petroleum produced in Colorado, 1909–1922, by districts.

[Thousands of barrels of 42 U. S. gallons.]

Year.	Boulder	Florence.	Other.	Total.	Year.	Boulder	Florence.	Other.	Total.
1909	86	225	.....	311	1916	6	191	.....	197
1910	42	194	4	240	1917	6	114	1	121
1911	38	187	2	227	1918	4	135	4	143
1912	15	191	.....	206	1919	5	102	14	121
1913	12	177	.....	189	1920	7	88	16	111
1914	6	216	1	223	1921	5	83	20	108
1915	6	202	.....	208	1922	4	70	23	97

Petroleum transported from producing properties in Colorado, 1921–1922, by districts and months.

[Thousands of barrels of 42 U. S. gallons.]

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	The year.
1921.													
Boulder	1	.....	.....	.....	1	1	1	.....	.....	.....	1	.....	5
Florence	7	7	8	7	8	7	6	7	7	7	6	6	83
Rangely	1	2	2	3	1	1	1	2	2	1	2	2	20
	9	9	10	10	10	9	8	9	9	8	9	8	108
1922.													
Boulder	.....	.....	1	.....	.....	.....	1	.....	.....	1	1	.....	4
Florence	5	6	6	7	7	7	5	6	5	6	5	5	70
Rangely	2	1	1	1	2	3	2	2	3	2	2	2	23
	7	7	8	8	9	10	8	8	8	9	8	7	97

Petroleum produced in Wyoming, 1914–1922, by districts.

[Thousands of barrels of 42 U. S. gallons.]

Year.	Big Muddy.	Byron-Greybull-Torchlight.	Elk Basin.	Grass Creek.	Hamilton Dome-Warm Springs.	Lance Creek.	Lander-Dallas.	Lost Soldier-Ferris.
1914	.....	96	.....	.....	.....	.....	27	.....
1915	(a)	141	.....	99	.....	.....	28	.....
1916	(a)	140	721	1,370	.....	.....	b 63	.....
1917	665	62	1,530	2,756	.....	.....	b 50	.....
1918	3,082	45	1,067	2,951	.....	.....	48	.....
1919	3,104	27	740	2,049	.....	461	62	167
1920	2,083	69	732	1,573	57	353	84	135
1921	1,927	80	681	1,435	67	346	119	524
1922	1,506	70	652	1,784	111	282	149	751

Year.	Mule Creek.	Osage.	Pilot Butte.	Rock Creek.	Salt Creek.	Teapot Dome.	Other.	Total.
1914	.....	.....	.....	.....	3,421	.....	16	3,560
1915	.....	.....	.....	.....	3,971	.....	7	4,246
1916	.....	.....	(b)	.....	3,933	.....	7	6,234
1917	.....	.....	(b)	.....	3,911	.....	4	8,978
1918	.....	.....	62	.....	5,337	.....	4	12,596
1919	.....	.....	91	242	6,225	.....	4	13,172
1920	182	16	69	1,370	10,090	.....	18	16,831
1921	68	176	46	1,681	12,172	.....	11	19,333
1922	168	182	38	1,728	19,248	37	9	26,715

a Included under "Other." b Pilot Butte included with Lander-Dallas.

Petroleum produced in California, by fields, to end of 1921.[a]

[Thousands of barrels of 42 U. S. gallons.]

Year.	Kern River.	McKittrick.	Midway.	Sunset.	Coalinga.	Santa Maria and Lompoc.	Summerland.
Prior to 1900	.....	25	.....	.....	678	.....	529
1900	827	80	.....	13	548	.....	183
1901	3,279	430	4	189	525	.....	204
1902	8,988	619	3	168	571	94	136
1903	16,342	1,353	27	352	2,138	205	131
1904	17,226	1,856	1	390	5,098	701	121
1905	15,254	1,373	19	419	8,882	3,403	97
1906	12,825	681	12	307	8,401	4,799	73
1907	12,346	2,416	150	705	8,996	8,249	69
1908	13,804	3,076	435	1,463	10,726	8,699	68
1909	14,508	5,807	2,234	2,000	15,407	8,018	66
1910	14,776	5,472	11,174	9,219	18,646	7,608	75
1911	14,079	5,478	21,585	5,559	18,311	7,465	71
1912	12,446	5,094	25,949	5,591	19,546	6,802	66
1913	9,981	4,497	33,040	5,985	18,605	5,818	62
1914	7,031	3,821	37,479	12,546	15,926	4,303	56
1915	8,035	3,553	33,311	6,007	13,548	4,537	53
1916	8,402	3,231	32,157	6,769	14,381	4,422	57
1917	8,496	3,253	29,488	7,072	15,939	5,798	56
1918	7,921	3,051	27,440	6,609	16,283	7,144	55
1919	7,563	2,811	26,414	5,590	16,386	6,031	54
1920	7,457	2,607	32,493	5,424	15,464	5,928	55
1921	6,716	2,056	42,258	4,614	12,341	5,563	54

Year.	Newhall and Ventura County.	Los Angeles and Salt Lake.	Whittier-Fullerton.	Lost Hills-Belridge.	Huntington Beach.	Miscellaneous.	Total.
Prior to 1900	8,253	5,091	290	.....	.....	29	14,895
1900	629	1,280	511	.....	.....	249	4,320
1901	496	1,830	753	.....	.....	.....	7,710
1902	647	2,027	1,104	.....	.....	.....	14,357
1903	682	794	2,306	.....	.....	4	24,334
1904	651	1,241	2,225	.....	.....	39	29,549
1905	477	2,227	2,117	.....	.....	30	34,298
1906	404	2,676	2,435	.....	.....	10	32,623
1907	436	3,372	3,294	.....	.....	69	40,102
1908	498	5,139	4,274	.....	.....	125	48,307
1909	517	4,351	5,157	.....	.....	127	58,192
1910	652	3,730	6,281	5	.....	59	77,697
1911	662	3,224	7,081	168	.....	61	83,744
1912	860	3,073	7,920	2,681	.....	46	90,074
1913	1,022	2,899	10,657	5,274	.....	27	97,867
1914	968	2,504	14,131	4,831	.....	28	103,624
1915	1,036	2,110	13,031	4,319	.....	27	89,567
1916	1,122	1,721	14,680	4,852	.....	28	91,822
1917	1,186	1,502	18,155	6,296	.....	27	97,268
1918	1,386	1,398	24,903	5,420	.....	28	101,638
1919	1,792	1,341	28,658	4,555	.....	27	101,222
1920	2,122	1,311	28,694	4,140	.....	26	105,721
1921	2,376	1,345	31,681	3,261	2,561	24	114,850

[a] Standard Oil Bulletin, March, 1922. Although these figures of production differ somewhat from those given in the table on page 373, this compilation presents valuable details by fields over a long period.

Petroleum produced in California, 1919–1922, by counties.[a]

[Thousands of barrels of 42 U. S. gallons.]

County.	1919	1920	1921	1922
Fresno	16,091	15,375	12,162	9,266
Kern	47,734	50,660	57,435	53,512
Los Angeles	15,077	14,026	12,396	37,726
Orange	14,459	15,463	22,929	31,049
San Luis Obispo	31	43	31	34
San Mateo				
Santa Barbara	6,089	5,804	5,466	3,931
Santa Clara	17	16	14	16
Ventura	1,685	1,990	2,167	2,934
	101,183	103,377	112,600	138,468

[a] California State Mining Bureau.

Petroleum produced in California in 1922, by fields.

[Barrels of "clean oil," from State Mining Bureau.]

Field.	Jan. 1 to June 30.	July 1 to Dec. 31.	Total.
District No. 1:			
Beverly Hills	82,586	92,636	175,222
Brea-Olinda	2,612,527	1,804,528	4,417,055
Coyote Hills	3,628,028	3,514,831	7,142,859
Huntington Beach	3,804,483	7,375,399	11,179,882
Long Beach	2,671,036	15,378,204	18,049,240
Montebello	3,723,299	2,891,362	6,614,661
Newhall	41,170	34,664	75,834
Redondo-Torrance	13,126	177,245	190,371
Richfield	4,419,320	3,890,375	8,309,695
Salt Lake	420,946	408,552	829,498
Santa Fe Springs	1,274,676	9,355,754	10,630,430
Whittier	527,401	402,160	929,561
	23,218,598	45,325,710	68,544,308
Los Angeles City field	(a)	(a)	231,732
District No. 2:			
Bardsdale	202,534	210,342	412,876
Conejo	2,550	635	3,185
Ojai	39,676	40,697	80,373
Piru	58,020	58,677	116,697
Santa Paula	17,272	19,125	36,397
Sespe	25,777	27,059	52,836
Simi	45,694	41,020	86,714
South Mountain	691,313	740,257	1,431,570
Ventura	191,719	521,318	713,037
	1,274,555	1,659,130	2,933,685
District No. 3:			
Arroyo Grande	17,844	16,012	33,856
Casmalia	657,895	634,534	1,292,429
Cat Canyon	357,805	255,516	613,321
Half Moon Bay	461	367	828
Lompoc	199,531	38,452	237,983
Santa Maria	1,055,091	681,968	1,737,059
Sargent	7,400	7,575	14,975
Summerland	25,275	25,088	50,363
	2,321,302	1,659,512	3,980,814
District No. 4:			
Belridge-Lost Hills-Devils Den	1,573,092	1,268,737	2,841,829
Elk Hills	6,621,946	4,982,368	11,604,314
Kern River	3,516,933	3,575,964	7,092,897
McKittrick-Temblor	1,191,652	1,149,378	2,341,030
Midway-Sunset	15,068,106	14,563,981	29,632,087
	27,971,729	25,540,428	53,512,157
District No. 5: Coalinga	6,110,207	3,155,319	9,265,526
Grand total	(a)	(a)	138,468,222

[a] Semiannual figures for Los Angeles City field not available.

WORLD'S PRODUCTION.

The world's production of petroleum in 1922 amounted to 858,715,000 barrels, an increase of 12 per cent over the output in 1921. This was almost double the world's production in 1915 and equaled 8 per cent of the world's total cumulative output of more than 10 billion barrels. Of this total, the United States has produced 62.3 per cent, Russia 19 per cent, and Mexico 8.8 per cent. In 1922, as contrasted with 1921, the United States increased its proportion of the world's production from 61.6 to 65.0 per cent and Mexico decreased its proportion from 25.2 to 21.2 per cent.

Mexico's production of 182,278,000 barrels of petroleum in 1922, a decrease of more than 11 million barrels compared with 1921, marks that country's first decline in production since it joined the rank of commercial producers in 1901. The decline was due to the falling off in yield of the Tampico-Tuxpam or Southern field, which produces so-called light oil having an approximate average gravity of 20° (0.933). This was in part offset by an increased yield of the Panuco Valley fields, which produce heavy oil having an approximate average gravity of 12° (0.986).

Petroleum produced in Mexico in 1922, by months.[a]

Month.	Barrels.	Month.	Barrels.
January	20,641,862	July	14,889,499
February	17,203,898	August	12,696,459
March	18,386,475	September	11,161,718
April	15,623,744	October	12,267,192
May	16,677,677	November	12,278,873
June	17,586,947	December	12,864,113

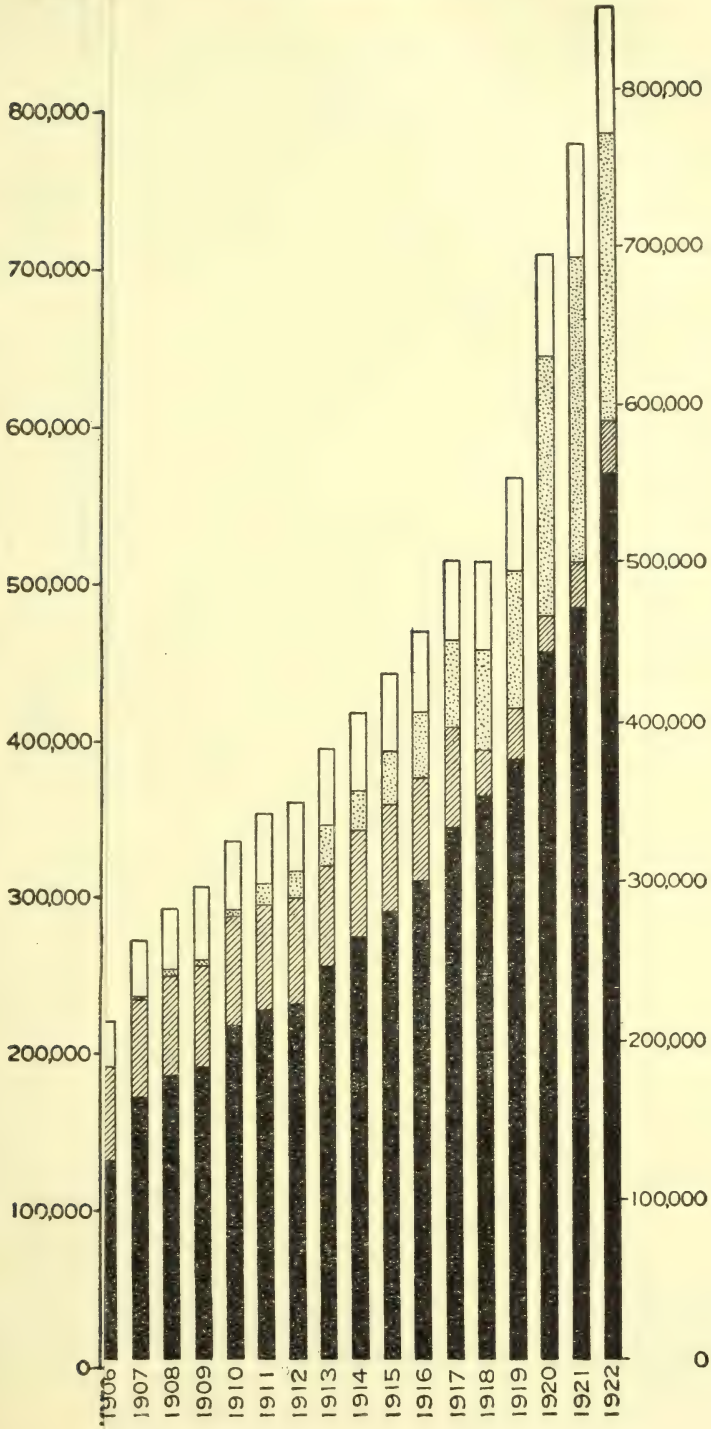
[a] Bol. del Petróleo, vol. 25, No. 2, 1923.

Persia continued to make noteworthy progress during 1922 and increased its production from 16,673,000 barrels in 1921 to 22,247,000 barrels, assuming fourth rank among the petroleum-producing countries and supplanting the Dutch East Indies.

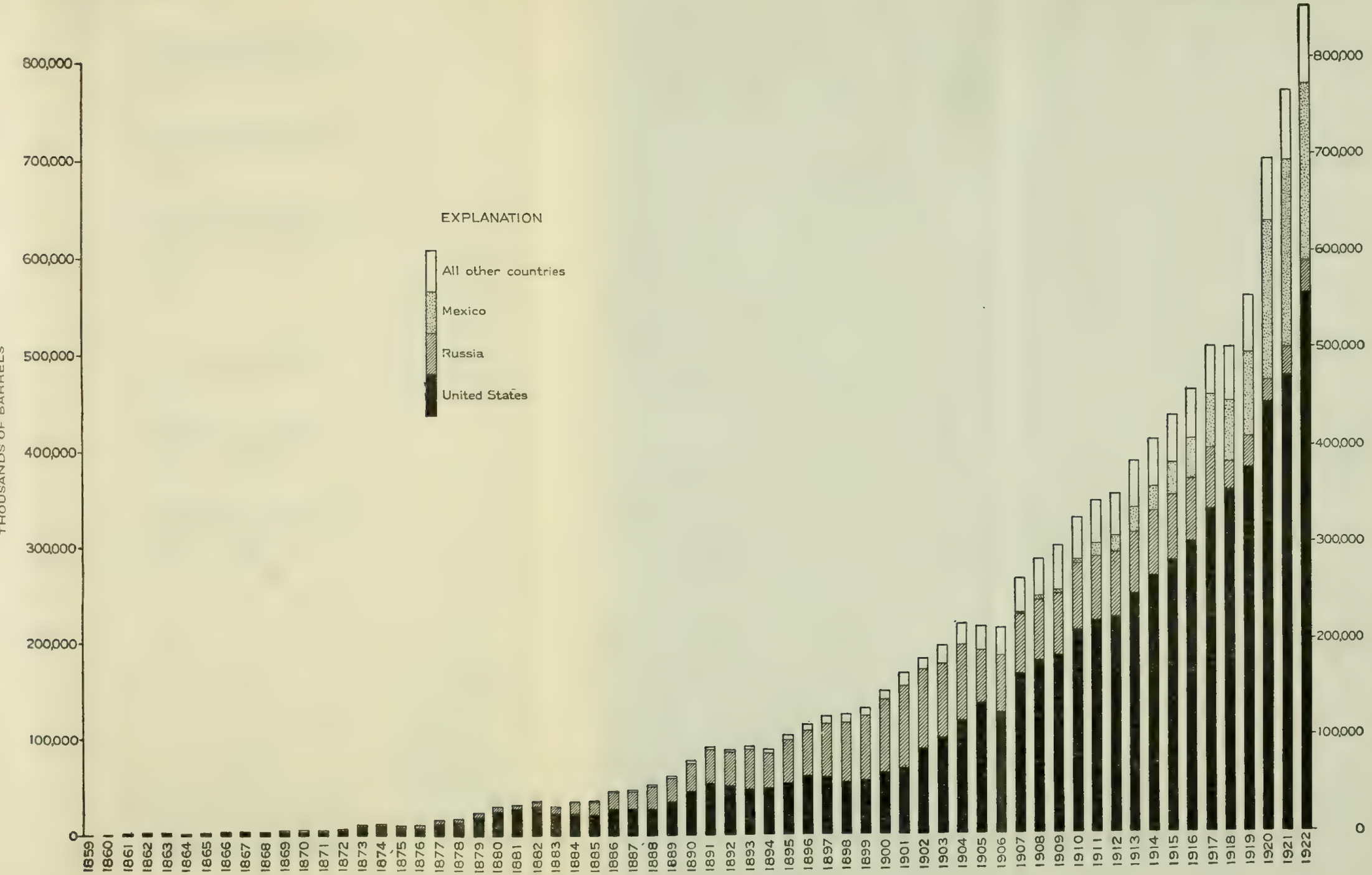
Another noteworthy increase was that of Russia, in which for the last three years increasing yield has been reported, advancing from the low point of approximately 25 million barrels in 1920 to over 35 million barrels in 1922. This production, however, was equivalent to little more than half of the pre-war rate. Substantial gains were also reported in Rumania and in British Borneo (Sarawak), in consequence of which Rumania advanced from seventh to sixth rank, supplanting India, and British Borneo from fourteenth to eleventh, passing Trinidad, Japan, and Venezuela.

Venezuela, by producing 2,201,000 barrels in 1922, increased its yield of 1921 by more than 50 per cent. Extensive developments in Venezuela indicate that within a few years, when transportation difficulties have been overcome, oil produced in the Maracaibo Basin will play a large part in the oil markets of the world. Colombia, which joined the ranks of the petroleum-producing countries in 1922, with a yield of 323,000 barrels, also looms up as an important factor in the not distant future.

The world's production from 1859 to 1922 is shown graphically in Plate II.



TRIES, 1859–1922.



PRODUCTION OF PETROLEUM IN THE UNITED STATES, RUSSIA, MEXICO, AND ALL OTHER COUNTRIES, 1859–1922.

World's production of petroleum in 1922 and total production, 1857–1922.

Country.	1922				1857–1922			
	Barrels of 42 U. S. gallons.	Metric tons.	Cubic meters.	Percentage of total by volume.	Barrels of 42 U. S. gallons.	Metric tons.	Cubic meters.	Percentage of total by volume.
United States	557,531,000	76,415,000	88,636,000	65.0	6,459,582,000	884,824,000	1,026,944,000	62.3
Mexico	[a] 182,278,000	27,312,000	[a] 28,979,000	21.2	912,199,000	136,336,000	145,021,000	8.8
Russia	35,692,000	[b] 4,864,000	5,675,000	4.2	1,968,681,000	260,885,000	312,981,000	19.0
Persia	[c] 22,247,000	2,966,000	3,537,000	2.6	89,919,000	11,989,000	14,296,000	.9
Dutch East Indies	16,720,000	[d] 2,324,000	2,658,000	1.9	253,341,000	34,393,000	40,276,000	2.4
Rumania	9,843,000	[e] 1,369,000	1,565,000	1.1	183,672,000	25,790,000	29,200,000	1.8
India	[f] 8,529,000	1,197,000	1,356,000	1.0	140,724,000	18,822,000	22,372,000	1.3
Peru	[g] 5,314,000	[g] 701,000	[g] 845,000	.6	38,810,000	5,158,000	6,171,000	.4
Poland (Galicia)	5,227,000	[h] 713,000	831,000	.6	179,574,000	24,834,000	28,549,000	1.7
Argentina	3,018,000	[i] 439,000	480,000	.4	12,286,000	1,807,000	1,953,000	
British Borneo (Sarawak)	2,849,000	[j] 410,000	453,000	.3	8,402,000	1,209,000	1,336,000	
Trinidad	[k] 2,445,000	340,000	389,000	.3	16,156,000	2,247,000	2,568,000	
Venezuela	2,201,000	[l] 335,000	350,000	.3	4,969,000	756,000	790,000	
Japan and Taiwan (Formosa)[m]	2,055,000	285,000	327,000	.2	45,876,000	6,372,000	7,293,000	
Egypt	1,188,000	[n] 173,000	189,000		9,582,000	1,378,000	1,523,000	
France (Alsace)	496,000	[o] 70,000	79,000		1,938,000	273,000	308,000	1.4
Colombia	[p] 323,000	46,000	51,000		323,000	46,000	51,000	
Germany	319,000	[q] 45,000	51,000		15,987,000	2,153,000	2,542,000	
Canada	[r] 179,000	25,000	28,000	.3	25,230,000	3,365,000	4,011,000	
Czechoslovakia	120,000	[s] 18,000	19,000		331,000	49,000	53,000	
Italy	31,000	[t] 4,000	5,000		1,107,000	157,000	176,000	
Algeria[u]	9,000				50,000	7,000	8,000	
England [v]	1,000	15,000	17,000		9,000	78,000	92,000	
Other	100,000				566,000			
	858,715,000	120,066,000	136,520,000	100.0	10,369,314,000	1,422,928,000	1,648,514,000	100.0

[a] Bol. del Petróleo, Feb., 1923.
[b] Gornyi Zhurnal, 1923.
[c] Anglo Persian Oil Co. (Ltd.).
[d] Royal Dutch Shell Co. only, Commerce Repts., Aug., 1923.
[e] Moniteur du petrole roumain, March 1, 1923.
[f] Geological Survey of India.
[g] Chief Bureau of Statistics, Cuerpo de ingenieros de minas.
[h] American Legation, Warsaw.
[i] Estimate, based on report of Director General of Mines for part of year.
[j] Royal Dutch Shell Co.
[k] Inspector of Mines.
[l] Memoria del Ministerio de Fomento.
[m] Section of Statistics, Dept. Agr. and Commerce of Japan.
[n] Ministry of Finance, Cairo.
[o] Trade Commissioner's report to Department of Commerce, Oct. 1, 1923.
[p] International Petroleum Co.
[q] Braunkohle, Sept. 15, 1923.
[r] Dominion Bur. Statistics.
[s] Commerce Repts., May 7, 1923.
[t] Rivista del servizio minerario.
[u] Governor General of Algiers, Bureau of Mines.
[v] Mines Dept. annual report of the Secretary for Mines and H. M. Chief Inspector of Mines.

World's production of crude petroleum

[Thousands of barrels

Year.	Rumania.	United States.	Italy.	Canada.	Russia.	Poland (Galicia).	Japan and Formosa.	Germany.	India.	Dutch East Indies.	Peru.	Mexico.	Argentina.
1857	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1858	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1859	4	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1860	9	500	(a)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1861	17	2,114	(a)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1862	23	3,057	(a)	12	.....	.....	.....	.....	.....	.....	.....	.....	.....
1863	28	2,611	(a)	83	41	.....	.....	.....	.....	.....	.....	.....	.....
1864	33	2,116	(a)	90	65	.....	.....	.....	.....	.....	.....	.....	.....
1865	39	2,498	2	110	67	.....	.....	.....	.....	.....	.....	.....	.....
1866	42	3,598	1	175	83	.....	.....	.....	.....	.....	.....	.....	.....
1867	51	3,347	1	190	120	.....	.....	.....	.....	.....	.....	.....	.....
1868	56	3,646	(a)	200	88	.....	.....	.....	.....	.....	.....	.....	.....
1869	59	4,215	(a)	220	202	.....	.....	.....	.....	.....	.....	.....	.....
1870	84	5,261	(a)	250	204	.....	.....	.....	.....	.....	.....	.....	.....
1871	90	5,205	(a)	270	165	.....	.....	.....	.....	.....	.....	.....	.....
1872	91	6,293	(a)	308	185	.....	.....	.....	.....	.....	.....	.....	.....
1873	104	9,894	(a)	365	475	.....	.....	.....	.....	.....	.....	.....	.....
1874	103	10,927	1	169	583	150	.....	.....	.....	.....	.....	.....	.....
1875	108	8,788	1	220	697	158	5	.....	.....	.....	.....	.....	.....
1876	111	9,133	3	312	1,321	164	7	.....	.....	.....	.....	.....	.....
1877	108	13,350	3	312	1,801	170	10	.....	.....	.....	.....	.....	.....
1878	109	15,397	4	312	2,401	176	18	.....	.....	.....	.....	.....	.....
1879	110	19,914	3	575	2,761	215	23	.....	.....	.....	.....	.....	.....
1880	115	26,286	2	350	3,001	229	26	9	.....	.....	.....	.....	.....
1881	122	27,661	1	275	3,601	287	17	29	.....	.....	.....	.....	.....
1882	136	30,350	2	275	4,538	330	15	58	.....	.....	.....	.....	.....
1883	139	23,450	2	250	6,002	365	20	27	.....	.....	.....	.....	.....
1884	211	24,218	3	250	10,805	408	28	46	.....	.....	.....	.....	.....
1885	193	21,859	2	250	13,925	465	30	41	.....	.....	.....	.....	.....
1886	168	28,065	2	584	18,006	306	38	74	.....	.....	.....	.....	.....
1887	182	28,283	1	526	18,368	344	29	74	.....	.....	.....	.....	.....
1888	219	27,612	1	695	23,049	467	37	85	.....	.....	.....	.....	.....
1889	298	35,164	1	705	24,609	515	53	68	94	.....	.....	.....	.....
1890	383	45,824	3	795	28,691	659	52	108	118	.....	.....	.....	.....
1891	488	54,293	8	755	34,573	631	53	109	190	.....	.....	.....	.....
1892	593	50,515	18	780	35,775	646	69	101	242	.....	.....	.....	.....
1893	535	48,431	19	798	40,457	693	106	100	299	600	.....	.....	.....
1894	508	49,344	21	829	36,375	949	173	123	327	688	.....	.....	.....
1895	576	52,892	26	726	46,140	1,453	170	121	372	1,216	.....	.....	.....
1896	543	60,960	18	727	47,221	2,444	237	145	430	1,427	47	.....	.....
1897	571	60,476	14	710	54,399	2,226	262	166	546	2,552	71	.....	.....
1898	776	55,364	15	758	61,610	2,376	319	184	542	2,964	71	.....	.....
1899	1,426	57,071	16	808	65,955	2,314	539	192	941	1,796	89	.....	.....
1900	1,629	63,621	12	913	75,780	2,347	871	358	1,079	2,253	274	.....	.....
1901	1,678	69,389	16	757	85,168	3,251	1,117	314	1,431	4,014	275	10	.....
1902	2,060	88,767	19	531	80,540	4,142	996	354	1,617	2,430	287	40	.....
1903	2,763	100,461	18	487	75,591	5,235	1,209	446	2,510	5,770	278	75	.....
1904	3,599	117,081	26	553	78,537	5,947	1,219	637	3,385	6,508	290	126	.....
1905	4,421	134,717	44	634	54,960	5,766	1,347	561	4,137	7,850	373	251	.....
1906	6,378	126,494	54	569	58,897	5,468	1,564	579	4,016	8,181	531	502	.....
1907	8,118	166,095	60	789	61,851	8,456	1,718	757	4,344	9,983	751	1,005	(a)
1908	8,252	178,527	51	528	62,187	12,612	1,871	1,009	5,047	10,283	945	3,933	12
1909	9,327	183,171	42	421	65,970	14,933	1,887	1,019	6,677	11,042	1,411	2,714	18
1910	9,724	209,557	51	316	70,337	12,673	1,829	1,032	6,138	11,031	1,258	3,634	20
1911	11,108	220,449	75	291	66,184	10,519	1,737	1,017	6,451	12,173	1,465	12,553	13
1912	12,976	222,935	54	243	68,019	8,535	1,659	1,031	7,117	10,846	1,752	16,558	47
1913	13,555	248,446	47	228	62,834	7,818	1,940	857	7,930	11,172	2,071	25,696	131
1914	12,827	265,763	40	215	67,020	6,436	2,636	781	7,410	11,422	1,837	26,235	276
1915	12,030	281,104	44	215	68,548	5,352	2,928	703	8,202	11,920	2,579	32,911	516
1916	8,945	300,767	51	198	65,817	6,587	2,963	656	8,491	12,547	2,593	40,546	797
1917	3,721	335,316	41	214	63,072	6,228	2,861	642	8,079	13,180	2,577	55,293	1,145
1918	8,730	355,928	35	305	27,168	6,032	2,441	270	8,188	12,778	2,527	63,828	1,243
1919	6,618	378,367	35	241	31,752	6,096	2,238	265	8,736	15,508	2,628	87,073	1,332
1920	7,435	442,929	35	196	25,430	5,607	2,221	246	8,375	17,529	2,817	163,540	1,657
1921	8,368	472,183	32	188	28,968	5,167	2,233	274	8,734	16,958	3,699	193,398	2,061
1922	9,843	557,531	31	179	35,692	5,227	2,055	319	8,529	16,720	5,314	182,278	3,018
	183,672	6,459,582	1,107	25,230	1,968,681	179,574	45,876	15,987	140,724	253,341	38,810	912,199	12,286

a Less than 1 thousand. *b* Estimated. *c* Cuba.

1857–1922, by years and countries.

of 42 U. S. gallons.]

Trinidad.	Egypt.	Persia.	Sarawak.	Algeria.	Venezuela.	France.	England.	Czechoslovakia.	Colombia.	Other countries.	Total.	Year.	Percentage produced by United States.
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	1857	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	1858	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	1859	33
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	509	1860	98
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,131	1861	99
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,092	1862	99
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,763	1863	94
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,304	1864	92
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,716	1865	92
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,899	1866	92
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,709	1867	90
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,990	1868	91
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,696	1869	90
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,799	1870	91
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,730	1871	91
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,877	1872	92
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,838	1873	91
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,933	1874	92
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,977	1875	88
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,051	1876	83
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,754	1877	85
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18,417	1878	84
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23,601	1879	84
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30,018	1880	88
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31,993	1881	86
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35,704	1882	85
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30,255	1883	78
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35,969	1884	67
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	36,765	1885	59
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	47,243	1886	59
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	47,807	1887	59
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	52,165	1888	53
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	61,507	1889	57
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	76,633	1890	60
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	91,100	1891	60
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	88,739	1892	57
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	92,038	1893	53
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	89,337	1894	55
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	103,692	1895	51
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	114,199	1896	53
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	121,993	1897	50
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	124,979	1898	44
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	131,147	1899	44
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	149,137	1900	43
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 20	167,440	1901	41
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 26	181,809	1902	49
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 36	194,879	1903	52
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 40	217,948	1904	54
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 30	215,091	1905	63
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 30	213,263	1906	59
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 30	263,957	1907	63
[a]	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 30	285,287	1908	63
57	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 20	298,709	1909	61
143	.....	.....	.....	.....	.....	.....	.....	.....	.....	[b] 20	327,763	1910	64
285	21	.....	.....	.....	.....	.....	.....	.....	.....	[b] 20	344,361	1911	64
437	214	.....	.....	.....	.....	.....	.....	.....	.....	[b] 20	352,443	1912	63
504	98	1,857	141	.....	.....	.....	.....	.....	.....	[b] 20	385,345	1913	64
644	753	2,910	318	1	.....	.....	.....	.....	.....	[b] 20	407,544	1914	65
750	212	3,616	392	4	.....	.....	.....	.....	.....	[b] 10	432,036	1915	65
929	464	4,477	629	8	.....	.....	.....	.....	.....	[b] 25	457,430	1916	66
1,602	943	7,147	542	9	120	.....	.....	.....	.....	[c] 19	502,751	1917	67
2,082	1,935	8,623	504	7	333	[d] 363	.....	.....	.....	.....	503,320	1918	71
1,841	1,517	10,139	596	5	425	334	2	48	.....	.....	555,796	1919	68
2,083	1,042	12,230	1,020	4	457	356	3	69	.....	.....	695,281	1920	64
2,354	1,255	16,673	1,411	3	1,433	389	3	94	.....	[c] 50	765,928	1921	62
2,445	1,188	22,247	2,849	9	2,201	496	1	120	323	[b] 100	858,715	1922	65
16,156	9,582	89,919	8,402	50	4,969	1,938	9	331	323	566	10,369,314	.....	62

[d] Production in previous years credited to Germany.

[e] Ecuador.

IMPORTS AND EXPORTS OF CRUDE PETROLEUM.

The statistics of imports and exports of crude petroleum given in the following tables are taken from the records of the Bureau of Foreign and Domestic Commerce, in which some topped oil is included with crude oil. Similar data for refined products of petroleum are given with refinery statistics on page 425.

During the first few months of 1922 imports of crude oil came in large quantity, the maximum of 14,018,000 barrels being received in May; at the end of the year, however, imports had been reduced to about half that quantity, reflecting the decreased production in Mexico.

In 1922, as in previous years, the greater part of the crude oil exported went to Canada. The table of exports of refined products, given on page 425, shows that approximately 13 per cent of the liquid refined products of petroleum manufactured in the United States in 1922 was exported, whereas less than 2 per cent of the crude petroleum produced in this country is exported.

Crude petroleum imported, exported, and shipped to Territories, 1909–1922.[a]

Year.	Imports.		Exports.	
	Barrels.	Value.	Barrels.	Value.
1909	[b] 66,283	[b] $198,540	4,055,661	$6,027,588
1910	[b] 571,354	[b] 1,425,902	4,288,361	5,404,253
1911	[b] 1,461,371	[b] 1,888,413	4,805,794	6,165,403
1912	[b] 6,909,231	[b] 4,656,317	4,493,129	6,770,484
1913	[b] 16,978,579	[b] 10,944,780	4,632,610	8,448,294
1914	[b] 16,913,121	[b] 10,023,097	2,969,894	4,958,838
1915	[b] 18,139,338	[b] 10,387,553	3,768,168	4,282,827
1916	[b] 20,796,865	[b] 12,574,266	4,095,902	7,029,923
1917	30,126,683	16,255,279	4,098,124	7,668,312
1918	37,735,641	21,319,464	4,900,691	12,084,250
1919	52,821,567	26,442,881	[c] 6,018,651	14,848,066
1920	106,175,289	55,799,254	[c] 8,757,092	29,986,874
1921	125,363,983	66,547,379	[c] 8,939,633	20,261,898
1922	127,308,423	70,383,309	[c] 10,162,817	18,422,231

Year.	Shipments to Territories from United States.					
	Alaska.		Hawaii.		Porto Rico.	
	Barrels.	Value.	Barrels.	Value.	Barrels.	Value.
1909	334,164	$334,258	1,039,083	$845,805	121	$340
1910	448,468	477,673	1,288,502	1,061,060	208	499
1911	431,961	406,400	1,114,084	917,763	1,229	2,899
1912	79,144	64,866	917,838	861,080	60	278
1913	4,727	4,723	772,493	598,980	35	117
1914	415,560	319,512	1,614,633	1,201,445	10	50
1915	332,623	268,474	1,636,669	1,174,284	23	85
1916	446,097	397,337	1,610,112	1,383,433	940	2,836
1917	482,218	635,480	1,644,357	1,988,508	3,404	11,007
1918	222,639	343,596	759,167	1,041,337	1,289	5,148
1919	71	422	328,805	552,690	4	18
1920	447	2,838	537,116	1,083,954	124	746
1921	.....	.....	687,173	1,393,831	6	50
1922	.....	.....	641,721	1,060,445	233	1,343

[a] Compiled from records of the Bureau of Foreign and Domestic Commerce. Prior to July 1, 1911, imports include all mineral oils. From July 1, 1911, to July 1, 1912, they include all mineral oils except benzine and gasoline. Since July 1, 1912, imports include crude and topped oil only.

[b] Import figures for 1909–1916 represent "general imports." Corresponding figures in earlier reports of this series represent "imports for consumption." For later years the figures for "general imports" and "imports for consumption" agree.

[c] Includes exports of foreign crude oil. Corresponding exports not included in figures prior to 1919. They were, however, negligible.

"Mineral crude oil" imported and exported in 1921–1922, by months.[a]

[Thousands of barrels of 42 U. S. gallons.]

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year. Thousands of barrels.	The year. Value (thousands of dollars).
1921.														
Imports:														
By countries—														
Mexico	13,257	11,384	12,303	10,104	9,148	10,255	8,047	3,352	9,139	11,635	12,986	13,684	125,294	66,491
Canada	1												1	4
Trinidad and Tobago												69	69	52
	13,258	11,384	12,303	10,104	9,148	10,255	8,047	3,352	9,139	11,635	12,986	13,753	125,364	66,547
By ports of entry—														
Atlantic coast	7,260	5,975	6,444	4,679	4,428	4,907	4,239	657	4,853	7,319	7,165	7,159	65,085	33,808
Gulf coast	5,687	5,270	5,529	5,109	4,217	5,142	3,725	2,695	4,196	4,316	5,591	6,361	57,838	31,433
Pacific coast	242	139	43	208	367	143	83		57		70	65	1,417	769
Northern border	1												1	4
Mexican border	68		287	108	136	63			33		160	168	1,023	533
	13,258	11,384	12,303	10,104	9,148	10,255	8,047	3,352	9,139	11,635	12,986	13,753	125,364	66,547
Exports:														
Domestic crude oil—														
Canada	580	552	651	676	716	454	437	748	728	577	602	446	7,167	14,196
Cuba	60	98	32	62	44	91	47		69	49	98		650	3,063
Germany					40			62	62	61	107	45	377	660
England	64						8			42			114	285
France		54					45		15				114	228
Panama		55						46					101	351
Other countries	31	10	46	5	66	41	1	29	7	18	57	32	343	1,421
Foreign crude oil	8	25	21	5	8						5	2	74	57
	743	794	750	748	874	586	538	885	881	747	869	525	8,940	20,261
Excess of imports over exports	12,515	10,590	11,553	9,356	8,274	9,669	7,509	2,467	8,258	10,888	12,117	13,228	116,424	46,286

[a] Compiled from records of the Bureau of Foreign and Domestic Commerce.

"Mineral crude oil" imported and exported in 1921–1922, by months—Continued.

[Thousands of barrels of 42 U. S. gallons.]

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October	November.	December.	The year. Thousands of barrels.	The year. Value (thousands of dollars).
1922.														
Imports:														
By countries—														
Mexico	13,036	12,077	14,004	11,659	13,950	12,104	10,339	10,203	[b] 4,674	[c] 9,919	7,189	7,041	126,195	70,383
Other countries	71				68	78	154	76	[b] 138	[c] 163	240	125	1,113	
	13,107	12,077	14,004	11,659	14,018	12,182	10,493	10,279	[b] 4,812	[c] 10,082	7,429	7,166	127,308	70,383
By ports of entry—														
Atlantic coast	6,390	5,964	8,491	5,056	7,517	5,816	5,296	5,786	[b] 2,887	[c] 5,025	4,220	4,644	67,092	70,383
Gulf coast	6,672	6,078	5,473	6,578	6,501	6,334	5,152	4,493	[b] 1,846	[c] 4,990	3,141	2,492	59,750	
Pacific coast	10			5					[b] 19	[c] 7	8		49	
Mexican border	35	35	40	20		32	45		[b] 60	[c] 60	60	30	417	
	13,107	12,077	14,004	11,659	14,018	12,182	10,493	10,279	[b] 4,812	[c] 10,082	7,429	7,166	127,308	70,383
Exports:														
Domestic crude oil—														
Canada	651	430	562	785	595	695	624	605	931	713	591	1,012	8,194	13,890
Cuba	69	66					107	52					294	
Germany				76			67		75		113	30	361	
England											136		136	4,458
France								11	34				45	
Panama								53	65				118	
Other countries		83	236	58	160	120	85	22		1	16	66	847	
Foreign crude oil	7	4	8	5	16	11	10	21	22	27	23	14	168	74
	727	583	806	924	771	826	893	764	1,127	741	879	1,122	10,163	18,422
Excess of imports over exports	12,380	11,494	13,198	10,735	13,247	11,356	9,600	9,515	[b] 3,685	[c] 9,341	6,550	6,044	117,145	51,961

[b] Imports cover Sept. 1 to 21.

[c] Imports cover Sept. 22 to Oct. 31.

STOCKS.

For statistical purposes stocks of crude petroleum are classified as (1) producers' stocks, including petroleum held on the producing properties (lease storage); (2) pipe-line and tank-farm stocks, including petroleum that has been removed from the producing properties but not delivered at refineries or at other points of consumption and is held on tank farms, in tanks along pipe lines, and in pipe lines; and (3) refinery and other consumers' stocks, including petroleum that has been delivered at refineries or at other points of consumption.

Producers', pipe-line, and tank-farm stocks are reported by the Geological Survey, and stocks of crude oil held at refineries are reported by the Bureau of Mines. Prior to 1923 refinery stocks of domestic and foreign crude oil were not differentiated, and there is duplication in the reports of refinery stocks and stocks of Mexican petroleum held in the United States by importers. This duplication has been eliminated since December, 1922. On December 31, 1922, there were 11,103,000 barrels of Mexican petroleum (crude and topped oil topped in Mexico) held by importers at refineries in the United States.

On December 31, 1918, shortly after the end of the war, stocks of crude petroleum, exclusive of consumers' stocks, had been reduced to 128,586,000 barrels, a supply sufficient for 113 days at the then current annual rate of deliveries to domestic consumers, plus exports. The previous high point was at the end of 1915, during the period of flush production of the Cushing field, when 194,185,000 barrels of crude oil was held in storage (exclusive of consumers' stocks), or enough for 241 days. Since 1918, in spite of increased consumption, stocks have increased greatly, and on December 31, 1922, producers', pipe-line, and tank-farm stocks of domestic crude oil and stocks of Mexican petroleum held in the United States by importers amounted to 273,006,000 barrels, but on account of the increased rate of consumption this was equivalent to a supply for only 165 days.

Monthly changes in stocks for the years 1921 and 1922 are shown in the table on pages 395–396.

Stocks of crude petroleum held in the United States on December 31, 1909–1922.

[Thousands of barrels of 42 U. S. gallons.]

Year.	Pipe-line and tank-farm stocks of domestic crude petroleum, by field of origin.								Producers' stocks.	Mexican petroleum held by importers (including topped oil topped in Mexico)	Total.	
	Appalachian field.	Lima-Indiana field.	Illinois-southwest Indiana field.	Mid-Continent field.	Gulf coast field.	Rocky Mountain field.	California field.	Total.			Quantity.[a]	Days' supply.[b]
1909	5,939	4,011	32,344	53,542	2,839	12	18,000	116,687	(c)	(c)	116,687	249
1910	5,007	4,730	31,325	[d] 54,179	[d] 2,674	30	33,085	131,030	(c)	(c)	131,030	244
1911	4,735	3,195	24,064	[d] 57,680	[d] 3,294	25	44,240	137,233	(c)	(c)	137,233	232
1912	4,031	2,420	15,710	51,538	1,472	147	47,552	122,870	(c)	(c)	122,870	184
1913	4,619	1,746	8,243	57,392	2,059	442	48,302	122,803	(c)	(c)	122,803	169
1914	5,725	1,648	13,564	60,818	3,964	170	55,661	141,550	(c)	(c)	141,550	196
1915	5,742	2,919	11,328	[e] 74,230	7,022	425	44,588	[e] 146,254	[e] 47,931	(c)	194,185	241
1916	3,850	2,088	6,600	[e] 77,307	9,315	745	39,398	[e] 139,303	[e] 40,069	(c)	179,372	200
1917	3,821	1,906	3,560	[e] 99,426	8,385	515	[f] 32,450	[e] 150,063	[g] 9,389	(c)	159,452	152
1918	3,616	1,029	2,367	79,094	8,168	236	[f] 32,043	126,553	[g] 2,033	(c)	128,586	113
1919	3,757	1,122	4,395	76,712	12,575	164	[f] 30,480	129,205	[g] 4,089	2,919	136,213	117
1920	3,673	1,286	3,495	91,696	12,311	299	[f] 22,240	135,000	[g] 3,586	7,442	146,028	99
1920 [h]	3,427	1,038	2,965	75,690	11,163	636	[f] 22,240	117,159	[g] 3,586	7,442	128,187	87
1921 [i]	6,838	1,014	7,567	102,401	17,606	1,635	[f] 35,022	172,083	[g] 5,139	13,540	190,762	130
1922 [i]	8,868	685	10,140	152,573	24,781	1,991	[j] 49,375	248,413	[g] 8,428	16,165	273,006	165

[a] For stocks of crude petroleum held at refineries see p. 425.
[b] Based on average daily rate for the year of deliveries to domestic consumers and exports.
[c] Not reported.
[d] Separation of northern and coastal Texas and Louisiana stocks estimated.
[e] In 1915 and 1916 stocks held off producing properties by certain companies were classed as producers' stocks, but for subsequent years similar stocks are classed as tank-farm stocks.
[f] From Standard Oil Bulletin; include, in addition to gross pipe-line and tank-farm stocks, some unfinished products of topping plants that were turned back to pipe lines and also producers' stocks.
[g] Exclusive of producers' stocks in California.
[h] As reported by revised method; see U. S. Geol Survey Mineral Resources, 1921, pt. 2, p. 284, 1923.
[i] Pipe-line and tank-farm stocks reported net.
[j] Producers', pipe-line, and tank-farm stocks (but not refinery stocks) of crude oil, residuum, and tops reported by American Petroleum Institute.

Stocks of crude petroleum held in the United States at end of each month in 1921.

[Thousands of barrels of 42 U. S. gallons.]

		January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Producers' stocks. Jan. 1.	Producers' stocks. Dec. 31.
Domestic petroleum:															
East of California: Pipe-line and tank farm stocks, by fields of origin:															
Appalachian—															
New York, Pennsylvania, West Virginia, eastern and central Ohio	gross	2,765	3,051	3,586	3,760	4,152	4,335	4,424	4,417	4,495	4,602	4,801	4,933	551	360
	net	2,486	2,772	3,307	3,484	3,888	4,061	4,150	4,138	4,229	4,339	4,536	4,670		
Kentucky	gross	1,024	1,389	1,487	1,447	1,677	1,870	1,867	2,107	2,140	1,973	2,064	2,204	42	85
	net	962	1,326	1,424	1,385	1,611	1,807	1,804	2,044	2,053	1,881	1,971	2,168		
Lima-Indiana	gross	1,452	1,107	1,519	1,555	1,536	1,575	1,624	1,686	1,548	1,536	1,501	1,386	59	48
	net	1,040	1,010	1,121	1,156	1,121	1,156	1,201	1,264	1,110	1,158	1,136	1,044		
Illinois and southwestern Indiana	gross	3,717	4,239	4,860	5,014	5,554	6,052	6,566	6,887	6,951	7,227	7,622	8,066	171	157
	net	3,189	3,710	4,332	4,490	5,030	5,526	6,075	6,396	6,473	6,733	7,122	7,567		
Mid Continent—															
Oklahoma, Kansas, central and north Texas	gross	78,552	80,322	84,135	87,445	90,938	94,436	98,518	99,713	100,107	99,732	99,293	102,012	1,857	3,113
	net	68,651	70,153	73,910	77,369	81,086	84,319	88,127	89,591	90,140	90,194	89,317	91,983		
North Louisiana and Arkansas	gross	8,129	8,145	8,070	8,065	8,558	9,379	10,096	10,298	10,163	9,766	9,963	10,912		
	net	7,535	7,636	7,652	7,606	8,090	8,902	9,485	9,765	9,650	9,199	9,493	10,418		
Gulf coast	gross	12,701	14,200	14,805	15,751	16,645	17,900	17,975	17,886	18,702	18,706	18,795	17,973	701	1,110
	net	11,248	12,730	13,386	14,113	15,295	16,310	16,176	16,360	17,150	17,159	17,422	17,606		
Rocky Mountain	gross	740	775	735	851	899	885	1,260	1,013	1,120	1,111	1,374	1,647	205	266
	net	727	760	726	842	888	874	1,247	1,007	1,113	1,098	1,360	1,635		
Total pipe-line and tank farm stocks east of California	gross	109,060	113,526	119,197	123,888	129,959	136,432	142,327	144,007	145,226	144,633	145,413	149,193	3,586	5,139
	net	95,838	100,147	105,858	110,745	117,012	122,985	128,865	130,565	131,918	131,761	132,357	137,061		
California: Gross pipe-line, tank farm, and producers' stocks [a]		22,594	22,904	24,214	25,357	28,055	29,769	31,654	33,830	33,671	33,116	33,486	35,022	[b] 2,092	[b] 2,859
Mexican crude petroleum and topped oil topped in Mexico held in the United States by importers:															
At Atlantic coast stations	crude	3,501	4,245	3,957	3,671	3,363	2,694	2,426	1,654	2,914	4,186	5,561	5,712	.....	.....
	topped	775	905	1,155	1,420	1,564	1,131	1,055	583	914	1,182	1,896	1,599	.....	.....
At Gulf coast stations	crude	2,348	3,162	3,637	4,458	4,241	4,496	3,573	2,465	2,598	2,564	3,523	5,413	.....	.....
	topped	533	859	678	718	882	1,243	1,123	581	859	1,340	1,437	816	.....	.....
At Pacific coast stations (crude)						150	145	145	14	-	-	-	-	.....	.....
Total Mexican petroleum		7,157	9,171	9,427	10,267	10,200	9,709	8,322	5,287	7,285	9,272	12,417	13,540	.....	.....
Total of net pipe-line and tank farm stocks east of California, gross pipe-line, tank farm, and producers' stocks in California, and stocks of Mexican petroleum held in the United States by importers		125,589	132,222	139,499	146,399	155,267	162,163	168,821	169,682	172,874	174,149	178,260	185,623	.....	.....

[a] Standard Oil Bulletin; includes, in addition to gross pipe-line and tank farm stocks, some unfinished products of topping plants that were turned back to pipe lines and also producers' stocks.

[b] Included in pipe-line and tank-farm stocks for California.

Stocks of crude petroleum held in the United States at end of each month in 1922.

[Thousands of barrels of 42 U. S. gallons.]

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November	December.	Producers' stocks Dec. 31.
Domestic petroleum:													
East of California: Pipe-line and tank-farm stocks, by fields of origin:													
Appalachian—													
New York, Pennsylvania, West Virginia, eastern and central Ohio	gross	4,990	5,191	5,330	5,772	5,925	6,031	6,019	5,965	6,072	6,215	6,201	6,200	341
	net	4,726	4,927	5,067	5,509	5,662	5,768	5,756	5,704	5,812	5,950	5,940	5,941	
Kentucky	gross	2,369	2,545	2,657	2,717	2,807	2,887	3,027	2,958	2,975	3,019	3,058	3,041	70
	net	2,267	2,542	2,554	2,614	2,704	2,784	2,924	2,856	2,866	2,904	2,943	2,927	
Lima-Indiana	gross	1,323	1,350	1,421	1,324	1,319	1,336	1,164	1,118	1,001	931	915	939	57
	net	990	1,029	1,101	1,031	1,029	1,046	902	859	728	676	661	685	
Illinois and southwestern Indiana	gross	8,418	8,723	8,878	9,410	9,612	9,925	10,199	10,436	10,488	10,353	10,532	10,641	166
	net	7,918	8,223	8,382	8,914	9,116	9,428	9,702	9,939	9,999	9,852	10,031	10,140	
Mid-Continent—														
Oklahoma, Kansas, central and north Texas	gross	106,832	113,954	121,079	129,376	135,831	140,211	144,246	147,054	147,971	148,410	147,612	147,456	6,095
	net	96,749	103,688	110,949	118,769	124,939	129,245	133,210	135,045	136,554	137,545	137,240	136,601	
North Louisiana and Arkansas	gross	11,915	13,208	14,799	15,575	16,095	16,662	16,452	16,440	16,196	15,897	16,001	16,617	
	net	11,412	12,701	14,256	15,003	15,502	16,034	15,848	15,820	15,567	15,266	15,370	15,972	
Gulf coast	gross	20,863	21,660	22,616	23,056	23,661	24,468	24,734	25,339	25,915	26,800	27,027	26,373	1,015
	net	19,322	20,227	21,177	21,569	22,241	22,970	23,054	23,597	24,154	25,071	25,431	24,781	
Rocky Mountain	gross	1,495	1,446	1,443	1,270	1,164	1,297	1,662	1,886	1,846	1,630	1,488	2,092	684
	net	1,415	1,432	1,428	1,263	1,154	1,280	1,649	1,861	1,828	1,620	1,475	1,991	
Total pipe-line and tank-farm stocks east of California	gross	158,205	168,077	178,223	188,500	196,414	202,817	207,503	211,196	212,464	213,255	212,834	213,269	8,428
	net	144,799	154,769	164,914	174,672	182,347	188,555	193,045	195,681	197,508	198,884	199,091	199,038	
California: Gross pipe-line, tank-farm, and producers' stocks [a]		36,185	36,702	37,992	39,795	42,041	43,477	45,188	45,078	46,742	47,741	48,851	49,375	[c] 6,907
Mexican petroleum held in the United States by importers:														
At Atlantic coast stations	crude	5,698	6,891	7,492	8,445	8,277	9,131	8,611	8,191	7,463	6,276	6,113	6,028	.....
	topped [b]	1,715	2,135	2,223	2,061	2,410	2,409	2,320	2,269	2,758	2,639	2,508	2,642	.....
At Gulf coast stations	crude	6,258	7,015	8,174	9,686	10,335	11,110	10,190	9,421	7,579	7,759	6,990	6,059	.....
	topped [b]	1,573	1,339	793	1,303	1,683	1,135	2,041	2,067	1,711	1,774	1,464	1,436	.....
Total Mexican petroleum		15,244	17,380	18,682	21,495	22,705	23,785	23,162	21,948	19,511	18,448	17,075	16,165	.....
Total of net pipe-line and tank-farm stocks east of California; pipe-line, tank-farm, and producers' stocks in California; and stocks of Mexican petroleum held in United States by importers		196,228	208,851	221,588	235,962	247,093	255,817	261,395	262,707	263,761	265,073	265,017	264,578	.....

[a] January to July, Standard Oil Bulletin; include, in addition to gross pipe-line and tank-farm stocks, some unfinished products of topping plants that were turned back to pipe lines and also producers' stocks. August to December, American Petroleum Institute: include producers', pipe-line, and tank-farm stocks (but not refinery stocks) of crude oil, residuum, and tops.

[b] Topped oil topped in Mexico.

[c] Included in pipe-line and tank-farm stocks for California.

CONSUMPTION.

Complete data concerning the consumption of crude petroleum are not available. Although petroleum is utilized chiefly in the form of refined products, concerning which summarized statistics are given on page 425, considerable crude oil, especially the heavier grades produced in the California, Gulf coast, and other domestic fields and heavy crude oil imported from Mexico, is consumed as such for fuel under boilers without topping or refining in any way. Data concerning these uses of crude oil, distinct from fuel oil, however, have not been compiled, and the only available figures of consumption of crude oil directly for fuel are those showing consumption in the operation of crude-oil pipe lines and consumption of oil on the producing properties given in the table on page 399. In the absence of a complete canvass of consumers, the best available index of the consumption of crude oil is furnished by figures showing indicated deliveries to domestic consumers obtained from the calculation that indicated deliveries equal production plus imports minus exports plus stocks (exclusive of consumers' stocks) at the beginning of the period minus stocks at the end of the period. These figures, however, should not be interpreted as showing actual consumption, for they do not take into account changes in stocks held by consumers, of which only figures showing refinery stocks are available, and, moreover, they include the unmeasured item of losses incurred after the oil leaves the producing properties and before it is actually consumed, involving shrinkage due to evaporation, leakage, and the presence of varying quantities of water, sediment, and other impurities.

Figures showing indicated deliveries to domestic consumers of crude petroleum are given in the table on pages 401–402, and a table showing some details of consumption for fuel of crude and fuel oil is given on page 399.

From 1911 to 1918, except in 1914, annual deliveries to domestic consumers plus exports of domestic and foreign crude petroleum have been greater than the quantity of domestic "petroleum marketed," and in 1916 to 1918 they were greater than domestic "petroleum marketed" plus imports. In 1919 and 1920 deliveries plus exports amounted to slightly less than combined production and imports, and in 1921 and 1922 they were considerably less, resulting in large additions to stocks. (See fig. 9.)

The monthly relation between supply—the sum of production, imports, and stocks—and demand, as indicated by deliveries to domestic consumers plus exports, between January, 1918, and December, 1922, is illustrated in Figure 12.

Throughout 1918, except in the month of June, deliveries plus exports exceeded production plus imports, and during the year pipe-line and tank-farm stocks were diminished by 23,510,000 barrels. In 1919 deliveries plus exports exceeded production plus imports in February, May, August, October, November, and December, but the net result for the year was a comparatively small surplus supply, and stocks were increased by 4,708,000 barrels. In 1920, from January to May, inclusive, deliveries plus exports exceeded production plus imports by a small margin; from June to December, however, in spite of increasing demand, the supply was greater,

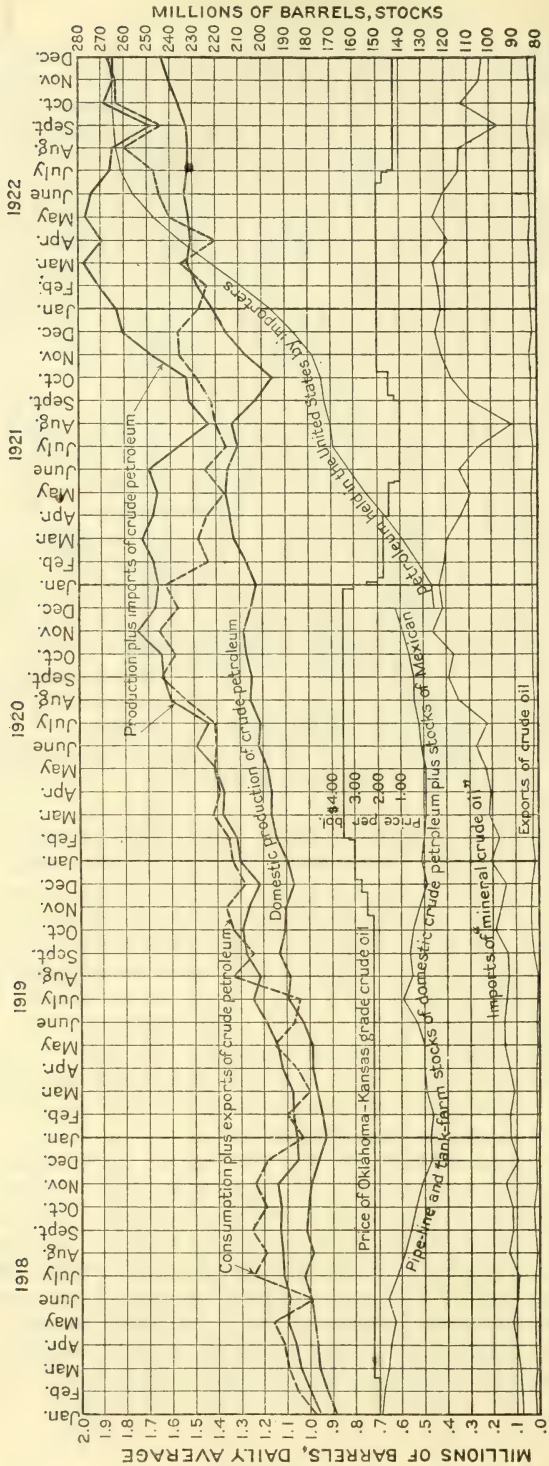

MILLIONS OF BARRELS, DAILY AVERAGE
MILLIONS OF BARRELS, STOCKS
Production plus imports of crude petroleum
Consumption plus exports of crude petroleum
Domestic production of crude petroleum
Petroleum landed in the United States by tankers
Price of Oklahoma-Kansas grade crude oil
Pipe-line and tank-farm stocks of domestic crude petroleum plus stocks of Mexican
Imports of mineral crude oil
Exports of crude oil
1918
1919
1920
1921
1922

FIGURE 12.—Daily average production, imports, indicated deliveries to consumers, and exports of crude petroleum, by months; stocks at end of month; and price of Oklahoma-Kansas grade crude petroleum, 1918–1922.

and by the end of the year stocks had been increased 9,815,000 barrels. During 1921, a year of industrial depression, demand decreased and the supply increased, and for each month deliveries plus exports were considerably less than production plus imports, so that by the end of December stocks had increased 62,575,000 barrels. In 1922 the demand increased but not so much as the supply, and the net result for the year was an increase of pipe-line, tank-farm, and producers' stocks of domestic crude oil and stocks of Mexican petroleum held in the United States by importers amounting to 82,244,000 barrels. During February and April deliveries to domestic consumers plus exports were less than domestic production, and throughout the year, except in December, they were less than production plus imports; but in December demand exceeded the supply for the first time since May, 1920. This condition was soon reversed, however, owing to the overproduction in 1923.

Some details of consumption for fuel of crude and fuel oil, 1919–1922.

[Thousands of barrels of 42 U. S. gallons.]

	1919	1920	1921	1922
Crude oil:				
On producing oil properties [a]	5,600	4,647	4,261	5,747
In operation of oil pipe lines [a]	Not available.		1,668	1,767
Fuel and gas oil (including some crude oil):				
By locomotives (all services, class 1 carriers) [b]	37,763	45,945	39,558	43,527
By vessels operated by or for account of U. S. Shipping Board [c]—				
Domestic oil	3,000	2,000	3,361	17,515
Mexican oil	7,000	14,742	11,936	
Open-market purchase	2,500	4,185	3,824	714
	12,500	20,927	19,121	18,229
By vessels cleared to foreign countries (bunker oil) [d]	14,031	26,335	27,076	31,692
By U. S. Navy (fiscal year) [e]	5,845	7,530	6,372	5,827
By electric public-utility power plants [f]	11,050	13,123	12,045	13,197
By manufacturers of artificial gas	[g] 22,700	[f] 21,982	[g] 21,380	[f] 20,238

[a] Reported to U. S. Geological Survey.
[b] Interstate Commerce Commission.
[c] Estimated by U. S. Shipping Board Emergency Fleet Corporation.
[d] Bureau of Foreign and Domestic Commerce.
[e] Navy Department.
[f] U. S. Geological Survey.
[g] American Gas Association.

The following figures, taken from volumes 8 and 11 of the Fourteenth Census, published in 1923, show the consumption of fuel oils in 1919 by some of the large industries not given in the foregoing table. Data are not available concerning the quantity of liquid fuel consumed for domestic use.

Fuel oils consumed in certain industries in 1919, in thousands of barrels.

Total reported	93,353	Foundry and machine shop	2,171
Petroleum refining	23,649	Paper and wood pulp	2,118
Iron and steel	9,701	Slaughtering and meat packing	1,891
Mining enterprises [a]	3,668	Cement	1,860
Cars and shop construction	3,666	Ice	1,622
Sugar	3,306	Brick and fire clay products	1,291
Smelting and refining metals	2,946	Shipbuilding	1,033

[a] Not including 6,080 thousand barrels for petroleum and natural-gas enterprises.

The rapidly increasing number of motor cars and oil-burning vessels, as shown below, emphasizes the growing demand for liquid fuels.

Motor-car registrations in the United States, 1915–1922.[a]

[Does not include motor cycles nor dealers' and manufacturers' licenses.]

1913	1,258,062	1919	7,565,446
1914	1,711,339	1920	9,231,941
1915	2,445,664	1921	10,465,995
1916	3,512,996	1922	12,238,375
1917	4,983,340	World total Jan. 1, 1923	14,612,161
1918	6,146,617		

[a] Statistical abstract of the United States, 1922, pp. 291, 736, Dept. Commerce Bur. Foreign and Domestic Commerce, 1923.

World oil-burning vessels.[a]

[Of 500 gross tons and over, exclusive of Army, Navy, admiralty, and other Government vessels.]

	Number.	Gross tonnage.
June 30, 1914	501	1,721,747
1920	2,021	9,039,247
1921	2,848	13,374,652
1922	3,110	15,004,548
1923	3,343	16,478,104

[a] American documented seagoing merchant vessels: Dept. Commerce Bur. Navigation Serial No. 64, Mar. 1, 1923.

Indicated deliveries to domestic consumers of domestic and imported crude petroleum, 1910–1922.

[Thousands of barrels of 42 U. S. gallons.]

	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919 [a]	1920	1921	1922
Domestic petroleum, by fields of origin:													
Appalachian	27,824	24,021	27,043	25,334	22,995	22,843	24,901	24,962	25,606	31,558	30,646	27,188	27,184
Lima-Indiana	6,535	7,766	5,701	5,447	5,160	2,999	4,736	3,852	4,098	2,656	2,246	2,439	2,589
Illinois and southwestern Indiana	34,163	38,578	36,955	31,361	16,599	21,278	22,442	18,817	14,559	10,623	12,321	6,346	7,649
Mid-Continent	58,580	63,095	71,615	79,066	94,569	109,882	133,858	[b] 164,481	199,715	194,991	235,025	230,494	257,838
Gulf coast	9,846	10,380	10,367	7,955	11,213	17,521	19,475	25,273	24,425	17,693	28,589	29,519	30,037
Rocky Mountain	337	419	1,656	2,300	4,055	4,199	6,156	9,429	13,088	13,380	17,180	19,890	28,487
California	57,925	69,979	83,957	97,039	92,417	97,664	96,142	[b] 105,464	97,939	102,746	111,617	99,818	124,115
Other	4	8	4	11	8	14	8	10	8	12	13	12	13
Consumption and exports	195,214	214,246	237,298	248,513	247,016	276,400	307,718	352,288	379,438	373,659	437,637	415,706	477,912
Exports of domestic crude oil	4,288	4,806	4,493	4,633	2,970	3,768	4,096	4,098	4,901	5,924	8,045	8,866	9,995
Consumption in the United States and Territories	190,926	209,440	232,805	243,880	244,046	272,632	303,622	348,190	374,537	367,735	429,592	406,840	467,917
Imported petroleum consumed in the United States and Territories	571	1,461	6,909	16,979	16,913	18,139	20,797	30,127	37,736	52,727	100,940	119,192	124,515
Consumption of domestic and imported petroleum in the United States and Territories	191,497	210,901	239,714	260,859	260,959	290,771	324,419	378,317	412,273	420,462	530,532	526,032	592,432

[a] Producers' stocks not used in the calculation of consumption prior to 1919.
[b] Calculation based on 100,401,000 barrels Mid-Continent stocks and 44,036,000 barrels California stocks as of Dec. 31, 1916.

Indicated deliveries to domestic consumers of domestic and imported crude petroleum, 1921–1922, by months.

[Thousands of barrels of 42 U. S. gallons.]

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	The year.
1921.													
Domestic petroleum, by fields of origin:													
Appalachian	2,509	1,776	2,129	2,486	2,158	2,154	2,399	2,449	2,353	2,472	2,111	2,192	27,188
Lima-Indiana	208	227	105	171	251	182	150	144	348	141	196	316	2,439
Illinois and southwestern Indiana	701	335	418	684	405	408	334	604	803	702	519	433	6,346
Mid-Continent	19,382	16,772	17,918	17,954	18,554	18,070	17,874	21,107	20,319	20,914	21,696	19,934	230,494
Gulf coast	2,834	1,378	2,641	2,034	2,101	1,701	2,729	3,280	2,284	3,000	2,813	2,724	29,519
Rocky Mountain	1,467	1,595	1,766	1,912	2,070	2,003	906	1,852	1,414	1,671	1,402	1,832	19,890
California	9,632	8,702	8,973	8,834	7,552	8,214	8,190	7,644	7,920	7,512	8,277	8,368	99,818
Other	1	1	1	1	1	1	1	1	1	1	1	1	12
Consumption and exports	36,734	30,786	33,951	34,076	33,092	32,733	32,583	37,081	35,442	36,413	37,015	35,800	415,706
Exports of domestic crude oil	735	769	729	743	866	586	538	885	881	747	864	523	8,866
Consumption in the United States and Territories	35,999	30,017	33,222	33,333	32,226	32,147	32,045	36,196	34,561	35,666	36,151	35,277	406,840
Imported petroleum consumed in the United States and Territories	13,535	9,345	12,026	9,229	9,237	10,746	9,434	6,387	7,141	9,648	9,836	12,628	119,192
Consumption of domestic and imimported petroleum in the United States and Territories	49,534	39,362	45,248	42,562	41,463	42,893	41,479	42,583	41,702	45,314	45,987	47,905	526,032
1922.													
Domestic petroleum, by fields of origin:													
Appalachian	2,080	1,793	2,399	1,886	2,287	2,413	2,316	2,689	2,306	2,318	2,345	2,352	27,184
Lima-Indiana	187	132	125	252	205	188	340	244	319	251	194	152	2,589
Illinois and southwestern Indiana	644	473	785	213	706	551	569	649	762	991	622	684	7,649
Mid-Continent	19,508	16,061	19,161	17,713	19,789	21,215	22,659	24,026	23,226	24,415	24,605	25,460	257,838
Gulf coast	1,566	2,025	2,040	2,612	2,487	2,279	2,902	2,575	2,498	2,386	2,800	3,867	30,037
Rocky Mountain	2,024	1,608	2,043	2,341	2,556	2,359	2,087	2,213	2,496	3,088	3,068	2,604	28,487
California	8,506	8,482	8,919	8,318	8,770	9,167	9,780	11,857	10,436	12,305	12,805	14,770	124,115
Other	1	1	1	1	1	1	1	1	1	1	1	2	13
Consumption and exports	34,516	30,575	35,473	33,336	36,801	38,173	40,654	44,254	42,044	45,755	46,440	49,891	477,912
Exports of domestic crude oil	720	579	798	919	755	815	883	743	1,105	714	856	1,108	9,995
Consumption in the United States and Territories	33,796	29,996	34,675	32,417	36,046	37,358	39,771	43,511	40,939	45,041	45,584	48,783	467,917
Imported petroleum consumed in the United States and Territories	11,396	9,937	12,694	8,841	12,792	11,091	11,106	11,472	7,227	11,118	8,779	8,062	124,515
Consumption of domestic and imported petroleum in the United States and Territories	45,192	39,933	47,369	41,258	48,838	48,449	50,877	54,983	48,166	56,159	54,363	56,845	592,432

PRICES.

The following table shows the average price per barrel paid for crude petroleum at the wells by States for the year 1922. The figures, which are based on reports of actual purchases, including premiums, show that the average prices ranged from $1.176 per barrel in Colorado to $3.260 in West Virginia.

Average price per barrel paid for crude petroleum at the wells, 1922, by States.

[Based on actual purchases, including premiums.]

Arkansas	$1.606
California [a]	1.252
Colorado	1.176
Illinois	2.056
Indiana:	
Southwestern	2.037
Northeastern	2.084
Total Indiana	2.047
Kansas	1.767
Kentucky	1.979
Louisiana:	
Northern	1.516
Coastal	1.252
Total Louisiana	1.502
Montana	1.653
New York	$3.144
Ohio:	
Central and eastern	2.695
Northwestern	2.249
Total Ohio	2.561
Oklahoma	1.726
Pennsylvania	3.210
Tennessee	1.758
Texas:	
Central and northern	1.765
Coastal	1.191
Total Texas	1.593
West Virginia	3.260
Wyoming	1.271

[a] California State Mining Bureau.

The posted price per barrel of crude petroleum at the wells and dates of change as announced by various purchasers during 1921 and 1922 are given in the tables on pages 406–414. Changes in price for crude petroleum during 1922 were less frequent and smaller than the violent changes during the post-war boom of 1919–1920 and the succeeding period of deflation, as shown in Figure 13. In 1922 the prices in general trended downward, as a consequence of the increasing supply of crude petroleum, in contrast with a slight upward movement in the wholesale price of all commodities.

As typical of changes during 1922, the variations in posted prices of Pennsylvania grade and of Oklahoma-Kansas (typical Mid-Continent) grade may be noted. The year began with the posted price at the wells of Pennsylvania grade of crude oil of $4 a barrel. The price dropped to $3.50 on January 3 and to $3.25 on January 9, at which it remained until June 5, when the price was raised to $3.50. On July 17 the price dropped to $3.25 and on July 19 to $3, where it remained until December 30, when it was raised to $3.25. The average for the year was $3.10.

The posted price of Oklahoma-Kansas grade crude oil at the wells started the year at the high point, $2 a barrel, following the reaction of the extreme low point, $1 a barrel, reached in 1921, and remained at $2 until July 15, when it was reduced to $1.75; on July 18 the price dropped to $1.50, and on August 2 there was a further drop to $1.25. On November 22 prices of Mid-Continent crude petroleum were put on a gravity basis by the large purchasing companies. The producer was thereafter paid for his petroleum more in accord with its quality; and the purchaser, who had previously paid a set price for oil of varying quality, guarded against receiving low-grade oil at a relatively high price.

Relations between monthly changes in price of Oklahoma-Kansas grade crude petroleum and of all commodities from 1913 to 1922, inclusive, shown by index numbers (monthly averages for the year 1913 being taken as 100) are shown in Figure 13; and relations between the price of Oklahoma-Kansas grade crude oil and the demand and supply of crude petroleum by months from 1918 to 1922 are shown in Figure 14. Supply is indicated by stocks at the beginning of the month plus production plus imports, and demand by deliveries to consumers plus exports.

Although the curves show a general parallelism in trend between prices of petroleum and the wholesale price of all commodities, there are certain pronounced variations due in part to supply and demand

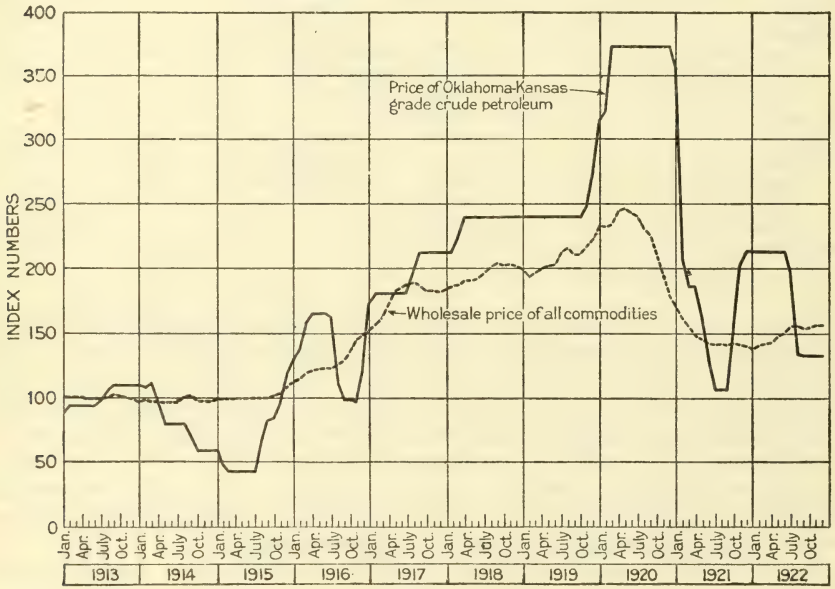


FIGURE 13.—Monthly average price of Oklahoma-Kansas grade crude petroleum at the wells and wholesale price of all commodities shown by index numbers, 1913–1922 (monthly average figures for 1913=100).

of petroleum. The low prices of crude oil in 1914 and 1915 were caused by the oversupply consequent to the flush production of the Cushing field. A marked reaction from this low level culminated early in 1916 and was followed later in the year by a secondary drop that may be ascribed to continued large supply. The stimulating effect of the war was marked in 1917 and 1918, and prices undoubtedly would have gone still higher but for the stabilization of prices brought about by the National Petroleum War Service Committee. During the post-war boom of 1919–1920 prices ran uncontrolled and reached exceptionally high levels, but they dropped precipitously during the following period of deflation. Late in 1921 prices reacted, and during the first half of 1922 they remained at a substantially higher level, until under the pressure of the increasing supply of petroleum they fell again but did not reach the low point of the preceding year.

FIGURE 14.—Supply and demand for crude petroleum contrasted with price of Oklahoma-Kansas grade crude petroleum, 1918-1922, by months.

Posted price per barrel of crude petroleum at wells, 1921–22, by grades, with dates of change.

Date.	Appalachian field.							Lima-Indiana field.		Illinois and southwestern Indiana field.		
	Pennsylvania.	Corning.	Cabell.	Wooster.	Ragland.	Somerset heavy.	Somerset light.	Lima-Ohio.	Indiana.	Illinois and Princeton, Ind.	Plymouth.	Waterloo.
1921.												
January 1	$6.10	$4.00	$4.46	$4.05	$2.60	$4.25	$4.50	$3.73	$3.63	$3.77	$3.48	.....
January 8	5.75	.....	4.21	.....	2.25	4.00	4.25	.....	.....	.....	.....	.....
January 10	.....	3.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
January 21	5.50	.....	3.96	.....	2.00	3.75	4.00	.....	.....	.....	.....	.....
January 25	.....	.....	.....	3.80	.....	.....	.....	3.48	3.38	3.52	3.23	.....
January 26	.....	3.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
January 31	5.00	.....	3.71	.....	1.75	3.50	3.75	.....	.....	.....	.....	.....
February 1	.....	.....	.....	3.55	.....	.....	.....	3.23	3.13	3.27	2.73	.....
February 2	.....	3.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February 4	4.75	.....	3.46	3.30	1.50	2.75	3.00	.....	.....	.....	.....	.....
February 5	.....	.....	.....	.....	.....	.....	.....	2.98	2.88	3.02	2.48	.....
February 10	.....	.....	.....	3.05	.....	.....	.....	2.73	2.63	2.77	2.23	.....
February 11	4.25	.....	2.96	.....	1.25	2.25	2.50	.....	.....	.....	.....	.....
February 14	.....	2.55	2.46	.....	.....	.....	.....	.....	.....	.....	.....	.....
February 15	3.75	.....	2.21	.....	1.15	2.00	2.25	.....	.....	.....	.....	.....
February 16	.....	2.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February 21	3.25	.....	1.96	.....	1.00	1.75	2.00	.....	.....	.....	.....	.....
February 23	.....	1.90	.....	.....	.....	.....	.....	.....	.....	.....	1.98	.....
February 26	3.00	.....	1.86	2.80	.....	1.65	1.80	2.48	2.38	2.52	.....	.....
March 10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.75	$1.75
April 18	3.25	2.15	1.96	.....	1.15	1.75	2.00	.....	.....	.....	.....	.....
April 25	3.50	.....	2.16	.....	1.25	1.95	2.20	.....	.....	.....	.....	.....
May 3	.....	.....	.....	2.55	.....	.....	.....	2.33	2.13	2.27	1.50	1.50
May 17	.....	2.00	1.91	.....	.....	1.70	1.95	.....	.....	.....	.....	.....
May 19	3.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May 23	.....	.....	.....	2.30	.....	.....	.....	2.08	1.88	2.02	.....	.....
May 25	3.00	1.90	1.81	.....	.....	1.60	1.80	.....	.....	.....	.....	.....
May 27	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.77	1.15	1.25
June 14	2.75	1.65	1.56	2.05	1.00	1.35	1.55	1.83	1.63	1.52	.90	1.00
June 16	2.50	1.40	1.31	.....	.75	1.10	1.30	.....	.....	.....	.....	.....
June 27	.....	.....	.....	1.80	.....	.....	.....	1.58	1.38	1.27	.65	.75
June 28	2.25	1.20	1.11	.....	.60	.90	1.00	.....	.....	.....	.....	.....
August 18	.....	.....	.....	.....	.....	1.10	1.25	.....	.....	.....	.....	.....
September 27	2.50	1.45	1.41	.....	.85	1.20	1.45	.....	.....	.....	.....	.....
October 4	2.75	1.65	1.61	2.05	.....	1.40	1.65	1.83	1.63	1.52	.90	1.00
October 7	3.00	1.90	1.86	.....	.....	1.65	1.90	.....	.....	.....	.....	.....

October 8				2.30				2.08	1.88	1.77	1.15	1.25
October 14	3.25		2.11		1.00	1.90	2.15					
October 20	3.50	2.15	2.36		1.15	2.15	2.40					
November 2	4.00	2.40	2.61		1.25	2.40	2.65					
November 9				2.70				2.48	2.28	2.27	1.65	1.75
Average for year	3.33	2.01	2.07	2.52	1.09	1.83	2.07	2.27	2.10	2.10	1.49	1.03
1922.												
January 3	3.50	2.15	2.36		1.15	2.15	2.40					
January 9	3.25	1.90	2.11		1.00	1.90	2.15					
February 6				2.60								
June 5	3.50		2.36		1.25	2.15	2.40					
June 6		2.05										
July 17	3.25		2.11	2.35		1.90	2.15	2.23	2.03	2.02	1.40	1.50
July 18		1.90										
July 19	3.00		1.86		1.00	1.65	1.90					
July 20		1.75		2.10				1.98	1.78	1.77	1.15	1.25
September 21				1.90								
December 30	3.25		2.11			1.90	2.15					
Average for year	3.10	1.86	2.03	2.33	1.03	1.82	2.07	2.25	2.05	2.04	1.42	1.52

Posted price per barrel of crude petroleum at wells, 1921–22, by grades, with dates of change—Continued.

Date.	Mid-Continent field.														
	Kansas, Oklahoma, northern and central Texas.								Northern Louisiana.[d]						
	Cement.[a]	Healdton.[a]	Oklahoma-Kansas grade.[b]	Breckenridge, Burkburnett, Desdemona, Electra, Holliday, Moran, Petrolia, Ranger.[c]	Corsicana heavy.[a]	Corsicana light.[a]	Currie,[c] 40° and above.	Mexia.[a]	Bellevue below 32°.	Bull Bayou.			Crichton, 38° and above.	De Soto.
										Below 32°.	32°–34.9°.	35°–37.9°.	38° and above.		
1921.															
January 1	$2.85	$2.75	$3.50	$3.50	$2.50	$3.00	.....	.....	.....	$2.00	$3.00	$3.05	$3.15	.....	$3.40
January 18	.....	2.25	.....	.....	2.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
January 21	2.35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
January 24	.....	.....	3.00	3.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
January 25	1.85	1.75	.....	.....	1.50	2.50	.....	.....	.....	1.50	2.50	2.55	2.65	.....	2.90
January 27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
January 31	1.35	1.25	2.50	2.50	1.00	2.00	.....	.....	.....	1.00	2.00	2.05	2.15	.....	2.40
February 1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February 3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February 4	1.00	1.00	2.00	2.00	.75	1.50	.....	.....	.....	.50	1.50	1.55	1.65	.....	1.90
February 8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February 9	.....	.....	1.75	1.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
February 11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
April 14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May 2	.....	.....	1.50	1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May 3	.....	.....	.....	.....	.....	1.25	.....	.....	.....	.25	1.25	1.30	1.40	.....	1.65
May 5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May 13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June 4	.75	.75	.....	.....	.50	1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....
June 11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June 13	.....	.....	1.25	1.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June 14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.00	1.05	1.15	.....	1.40
June 15	.....	.....	1.00	1.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June 16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.75	.80	.90	.....	1.15
June 18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
June 21	.....	.60	.....	.....	.....	.85	.....	.....	.....	.....	.....	.....	.....	.....	.....
September 3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
September 13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
September 23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
September 28	.....	.....	.....	1.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
September 30	.85	.70	.....	.....	.60	.95	.....	.....	.....	.....	.....	.....	.....	.....	.....
October 1	.....	.....	1.25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
October 3	.....	.....	.....	1.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] Magnolia Petroleum Co. [b] Prairie Oil & Gas Co. [c] Texas Co. [d] Standard Oil Co. of Louisiana.

October 4	.95	.80							.70	1.05				.50	1.00	1.05	1.15		1.25
October 5															1.25	1.30	1.40		1.50
October 7				1.50			1.75												
October 8									.85	1.20		$0.60							
November 7				2.00			2.25												
November 8	1.10	.95										.75		1.00	1.75	1.80	1.90		2.00
November 9																			
November 10																			
December 15	1.30	1.30							.95	1.30		1.00							
December 21																			
Average for year	1.07	.99		1.65			1.71		.82	1.32		.75		.61	1.38	1.43	1.53		1.74
1922.																			
January 1																		$1.75	
January 16												1.25							
January 18																			
February 14		1.00							.75										
February 22														$1.00					
March 17												1.50							
March 23																			
April 20																			
May 25																			
July 13											$1.75								
July 15				1.75			2.00												
July 18	1.10	.85		1.50						1.10				.75	1.50	1.55	1.65	1.50	1.75
July 19	1.00	.75							.65	1.00					1.25	1.30	1.40	1.25	1.50
July 20							1.75				1.50								
July 21												1.25							
August 2				1.25			1.50												
August 3															1.00	1.05	1.15	1.00	1.25
August 4	.85																		

	Below 28°.	28°–29.9°.	30°–32.9°.	33°–34.9°.	35°–36.9°.	37°–38.9°.	39° and above											
November 22[1]	$0.90	$1.00	$1.10	$1.25	$1.40	$1.60	$1.80											
December 5																		
December 11																		
December 14										1.60								
December 15												1.35						
December 16															1.25	1.30	1.40	1.25	1.60
December 28										1.80									
December 29												1.55							
Average for year								.73	1.16	1.53	1.33	.87			1.43	1.48	1.58	1.43	1.68

[1] Texas Co., Nov. 23.

Posted price per barrel of crude petroleum at wells, 1921–22, by grades, with dates of change—Continued.

Date.	Mid-Continent field—Continued.															Gulf coast field.			
	Northern Louisiana.[d]												Arkansas.[d]			Coastal Texas.			Coastal Louisiana.[f]
	Caddo.				Haynesville.				Homer.				El Dorado.						
	Heavy.	32°–34.9°.	35°–37.9°.	38° and above.	Below 32°.	32°–33.9°.	34°–35.9°.	36° and above.	Below 32°.	32°–34.9°.	35°–35.9°.	36° and above.	Below 33°.	33°–34.9°.	35° and above.	Smackover.	Batson,[e] Dayton, Goose Creek, Hull Grade A, Humble, Saratoga, Sourlake, Spindletop, Columbia. Markham.	Blue Ridge,[f] Pierce Junction Grade B, Hull Grade B.[g]	Cow Bayou.[e]	Edgerley, Jennings, Vinton.
1921.																			
January 1	$2.50	$3.35	$3.40	$3.50						$3.10	$3.15	$3.25			$0.75		$2.50		$2.50	$2.50
January 18																	2.00		2.00	2.00
January 21																				
January 24																				
January 25	2.00	2.85	2.90	3.00					$1.25	2.60	2.65	2.75								
January 27	1.50																			
January 31																				
February 1		2.35	2.40	2.50						2.10	2.15	2.25					1.50		1.50	1.50
February 3	1.25																			
February 4																				
February 8		1.85	1.90	2.00						1.60	1.65	1.75								
February 9																				
February 11																	1.25		1.25	1.25
April 14																	1.00		1.00	1.00
May 2																				
May 3		1.60	1.65	1.75					1.00	1.35	1.40	1.50								
May 5	1.00																			
May 13																				
June 4															.70					
June 11					$1.00	$1.10	$1.15	$1.25												
June 13																	.80		.80	.80
June 14		1.35	1.40	1.50	.75	.85	.90	1.00	.75	1.10	1.15	1.25								

June 15																			
June 16	.80	1.10	1.15	1.25	.50	.60	.65	.75	.50	.85	.90	1.00							
June 18	.60																		
June 21					Below 34°.		34° and above.						Below 34°	34° and above.					
September 3													$0.70	$0.80					
September 13					$0.65		$0.75												
September 23													.80	.90					
September 28					.75		.85						.90	1.00					
September 30																			
October 1																			
October 3																			
October 4																			
October 5	.85				1.00		1.10		.75	1.10	1.15	1.25	1.15	1.25					
October 7	1.10	1.35	1.40	1.50	1.25		1.35		1.00	1.35	1.40	1.50	1.40	1.50		1.00		1.00	1.00
October 8																			
November 7																1.25		1.25	1.25
November 8		1.85	1.90	2.00	1.75		1.85		1.50	1.85	1.90	2.00	1.75	2.00					
November 9																			
November 10	1.25																		
December 15																			
December 21																	$0.80		
Average for year	1.10	1.67	1.72	1.82					1.04	1.48	1.53	1.66				1.14		1.14	1.14
1922.																			
January 1																			
January 16																			
January 18																		1.00	
February 14																			
February 22					*h* 1.40		*h* 1.50												
March 17																			
March 23					*k* 1.40		*k* 1.50												
April 20																			
May 25																		1.25	
July 13																			
July 15																			
July 18	1.00	1.60	1.65	1.75	1.50		1.60		1.25	1.60	1.65	1.75	1.50	1.75					
July 19	.75	1.35	1.40	1.50	1.25		1.35		1.00	1.35	1.40	1.50	1.25	1.50					
July 20																			
July 21																			
August 2																			
August 3		1.10	1.15	1.25	1.00		1.10		.75	1.10	1.15	1.25	1.00	1.25					
August 4																			

d Standard Oil Company of Louisiana.
e Gulf Pipe Line Co.
f Gulf Refining Co. of Louisiana.
g Humble Oil & Refining Co.
h Covering one-third of production run into storage.
k Covering 45 per cent of production run into storage.

88484°—25——27

Posted price per barrel of crude petroleum at wells, 1921–22, by grades, with dates of change—Continued.

Date	Mid-Continent field—Continued.											Gulf coast field.			
	Northern Louisiana.									Arkansas.		Coastal Texas.			Coastal Louisiana.
	Caddo.				Haynesville.		Homer.			El Dorado.					
	Heavy.	32°–34.9°.	35°–37.9°.	38° and above.	Below 33°.	33° and above.	Below 31°.	31°–32.9°.	33°–34.9°.	35° and above.	Below 33°.	33° and above.	Smackover.	Batson, Dayton, Goose Creek, Hull Grade A, Humble, Saratoga, Sourlake, Spindletop, Columbia, Markham.	Blue Ridge, Pierce Junction Grade B, Hull Grade B.	Cow Bayou.	Edgerley, Jennings, Vinton.
August 24					$1.00	$1.10	$ .75	$1.10	$1.15	$1.25	$1.00	$1.25					
September 27													$0.75				
November 4													.50				
November 22 [1]																	
	Below 30°.		30°–32.9°.		33°–34.9°.		35°–36.9°.		37°–38.9°.		39° and above.						
December 5	$0.75		$1.10		$1.25		$1.40		$1.60		$1.80						
December 11													.30				
December 14																	
December 15																	
December 16																	
December 28																	
December 29																	
Average for year													.55	$1.25	$0.80	$1.16	$1.25

[1] Texas Co., Nov. 23.

Date.	Rocky Mountain field.[a]										
	Ferris.	Grass Creek, Elk Basin, Greybull, Torchlight.	Lance Creek.	Osage.	Lander heavy crude.	Lost Soldier	Mule Creek.	Rock Creek.	Salt Creek, Big Muddy, Hamilton Dome.	Cat Creek.	Sunburst.[b]
1921.											
January 1		$3.10	$3.05		$2.00		$2.05	$2.75	$2.75		
January 25		2.60	2.55		1.25		1.80	2.35	2.25	$2.60	
February 1		2.25	2.20				1.45	2.00	1.90	2.25	
February 5		2.00	1.95		1.00		1.20	1.75	1.65	2.00	
February 10	$1.60	1.75	1.70	$1.70	.8725		.95	1.50	1.40	1.75	
May 3	1.35	1.50	1.45	1.45	.71			1.25	1.15		
May 21	1.20				.6125		.80	1.10	1.00	1.50	
June 14	.95	1.25	1.20	1.20	.45			.85	.75	1.25	
June 17	.85	1.15	1.10	1.10	.385		.70	.75	.65	1.15	
June 22							.60				
June 27	.70	1.00	.95	.95	.2875		.45	.60	.50	1.00	
October 4	.95	1.25	1.20	1.20	.45		.70	.85	.75	1.25	
October 8	1.10	1.45	1.40	1.35	.5475		.85	1.05	.90	1.45	
November 8	1.60	1.90	1.90	1.90	.8725		1.30	1.50	1.40	1.90	
Average for year	1.20	1.60	1.56	1.41	.82		.91	1.25	1.16	1.51	
1922.											
July 18	1.35	1.65			.71	$1.15	1.05	1.25	1.15	1.65	
July 19	1.10	1.40			.5475	.90	.80	1.00	.90	1.40	
August 4	.90	1.20			.4175	.70	.60	.80	.70	1.20	
October 31											$0.70
December 22	1.25	1.50			.70	1.05	.90	1.15	1.05	1.50	
Average for year	1.30	1.60			.6786	1.10	1.00	1.20	1.10	1.60	.70

[a] Midwest Refining Co.

[b] Ohio Oil Co.

Posted price per barrel of crude petroleum at wells, 1921–22, by grades, with dates of change—Continued

Date.	California field.[a]																	
	14°–17.9°	18°–18.9°	19°–19.9°	20°–20.9°	21°–21.9°	22°–22.9°	23°–23.9°	24°–24.9°	25°–25.9°	26°–26.9°	27°–27.9°	28°–28.9°	29°–29.9°	30°–30.9°	31°–31.9°	32°–32.9°	33°–33.9°	34°–34.9°	35° and above.
1921.																			
January 1	$1.60	$1.61	$1.63	$1.66	$1.70	$1.75	$1.81	$1.88	$1.96	$2.05	$2.15	$2.25	$2.35	$2.45	$2.55	$2.65	$2.75	$2.85	$2.95
May 13	1.35	1.36	1.38	1.41	1.45	1.50	1.56	1.63	1.71	1.80	1.90	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70
August 3	1.10	1.11	1.13	1.16	1.20	1.25	1.31	1.38	1.46	1.55	1.65	1.75	1.85	1.95	2.05	2.15	2.25	2.35	2.45
Average for year	1.34	1.35	1.37	1.40	1.44	1.49	1.55	1.62	1.70	1.79	1.89	1.99	2.09	2.19	2.29	2.39	2.49	2.59	2.69
1922.																			
July 15	.85	.85	.85	.88	.92	.98	1.05	1.13	1.21	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
July 25	.60	.60	.60	.63	.67	.73	.80	.88	.96	1.05	1.15	1.25	1.35	1.45	1.55	1.65	1.75	1.85	1.95
Average for year	.87	.88	.89	.92	.96	1.01	1.08	1.15	1.23	1.32	1.42	1.52	1.62	1.72	1.82	1.92	2.02	2.12	2.22

[a] Standard Oil Co.

WELLS.

The enumeration in the following table is based on reports of companies that operate gathering lines, supplemented by reports of producers.

Productive oil wells in the United States December 31, 1922.

State.	Approximate number of wells.	Production per well per day (barrels).	State.	Approximate number of wells.	Production per well per day (barrels).
Arkansas	[a] 964	54.6	Ohio:		
California	[b] 8,916	55.3	Central and eastern	20,300	0.6
Colorado	75	3.2	Northwestern	19,000	.3
Illinois	16,725	1.4	Total Ohio	39,300	.5
Indiana:			Oklahoma	57,500	7.5
Southwestern	1,050	2.1	Pennsylvania	75,000	.3
Northeastern	1,500	.4	Texas:		
Total Indiana	2,550	1.1	Coastal	2,200	44.5
Kansas	17,900	4.4	Rest of State	13,250	14.2
Kentucky	10,600	2.1	Total Texas	15,450	18.5
Louisiana:			West Virginia	20,200	.9
Northern	3,370	22.9	Wyoming	1,750	53.6
Coastal	130	43.7		284,880	5.7
Total Louisiana	3,500	23.6			
Montana	150	52.0			
New York	14,300	.2			

[a] Bureau of Mines.
[b] American Petroleum Institute; does not include wells temporarily shut in.

The following tables of wells drilled for oil and gas, including dry holes, were compiled for the States east of California from reports published in the Oil and Gas Journal, and for California prior to 1922 from the Standard Oil Bulletin, supplemented in years prior to 1919 by reports of producers. California well data for the year 1922 were obtained from the American Petroleum Institute.

The fluctuations in the number of oil wells completed from year to year vary roughly with the major fluctuations in price of crude oil. In 1915 and 1921, for instance, when prices of crude oil were unusually low, there was a correspondingly small number of well completions as compared with the number in 1916 and 1920, when prices of crude oil were high. But, although low prices tend to discourage wildcatting and result in fewer completions, the element of accident independent of price that enters into the discovery of new pools has prevented low prices from halting the progressive increase in the production of petroleum from year to year.

During the year 24,689 wells were drilled in search of oil and gas in the United States. Of the wells reported, 70 per cent produced oil, 8 per cent were gas wells, and 22 per cent were dry holes. Throughout the country as a whole east of California (similar data for California are not available) these percentages have remained fairly constant for a number of years. In the several States, however, the results vary considerably, as shown in the tables and in Figure 15. The fact that more than 5,000 dry holes have been sunk annually since 1918 in search of oil and gas should prompt the en-

deavor to reduce this item of waste by the more general use of applied geology.

The greatest drilling activity in 1922 was in Oklahoma, where 6,148 wells were completed; then followed, in the order named, Texas, Pennsylvania and New York (combined), Ohio, Kentucky, Kansas, and Louisiana, in each of which more than 1,000 wells were put down in search of oil and gas. In California 837 oil wells were completed. The average initial daily capacity of the oil wells drilled in the States east of California in 1922 ranged from 870 barrels in coastal Texas down to 6 barrels in Pennsylvania and New York.

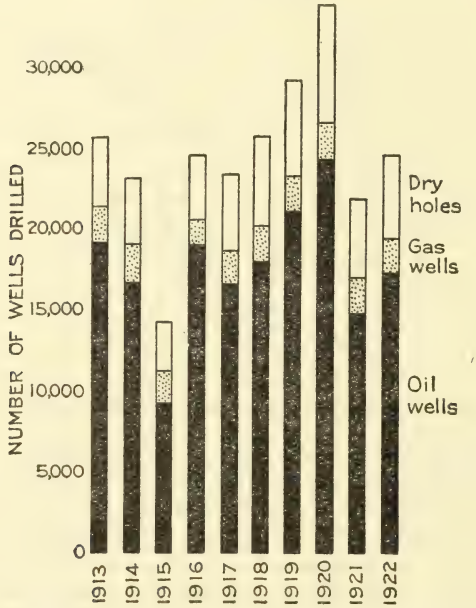


FIGURE 15.—Wells drilled for oil and gas in the United States, including dry holes, 1913–1922.

Summary of wells drilled in the United States, 1913–1922.

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Wells completed:										
Oil	19,101	16,668	9,154	18,777	16,590	17,845	21,052	24,273	14,666	17,333
Gas	2,207	2,327	2,022	1,803	1,966	2,229	2,135	2,274	2,111	2,024
Dry	4,282	4,142	2,981	4,039	4,851	5,613	5,986	7,364	5,160	5,332
	25,590	23,137	14,157	24,619	23,407	25,687	29,173	33,911	21,937	24,689
Percentage of total wells drilled:										
Oil	74.7	72.0	64.7	76.3	70.9	69.5	72.2	71.6	66.9	70.2
Gas	8.6	10.1	14.2	7.3	8.4	8.7	7.3	6.7	9.6	8.2
Dry	16.7	17.9	21.1	16.4	20.7	21.8	20.5	21.7	23.5	21.6
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Wells drilled in the United States, 1920–1922, by States.

	1920				1921				1922			
	Oil.	Gas.	Dry.	Total.	Oil.	Gas.	Dry.	Total.	Oil.	Gas.	Dry.	Total.
Arkansas	2	1	11	14	558	42	46	646	593	46	91	730
California	572	(a)	(a)	a 572	704	(a)	(a)	a 704	837	(a)	(a)	a 837
Illinois	257	3	125	385	165	.....	102	267	252	2	87	341
Indiana	354	5	109	468	237	1	79	317	170	6	55	231
Kansas	2,320	148	695	3,163	913	113	354	1,380	1,057	86	497	1,640
Kentucky	2,542	66	265	2,873	1,935	64	469	2,468	1,790	69	409	2,268
Louisiana:												
Northern	841	112	211	1,164	327	55	186	568	827	67	160	1,054
Coastal	101	.....	76	177	46	1	66	113	61	2	22	85
Total Louisiana	942	112	287	1,341	373	56	252	681	888	69	182	1,139
Michigan	1	.....	3	4	4	1	.....	5	.....	.....	.....	.....
Montana	.....	.....	.....	.....	61	.....	33	94	53	4	27	84
Ohio:												
Southeastern	1,502	354	722	2,578	898	405	531	1,834	1,046	482	546	2,074
Northwestern	478	7	80	565	372	.....	89	461	449	12	61	522
Total Ohio	1,980	361	802	3,143	1,270	405	620	2,295	1,495	494	607	2,596
Oklahoma	6,304	757	2,036	9,097	3,545	660	1,509	5,714	4,149	571	1,428	6,148
Pennsylvania and New York	2,263	189	317	2,769	1,565	208	244	2,017	2,262	270	274	2,806
Tennessee	7	.....	8	15	17	1	13	31	16	1	15	32
Texas:												
Central and Northern	4,728	243	1,717	6,688	2,052	174	758	2,984	2,290	81	906	3,277
Coastal	772	34	609	1,415	482	38	361	881	607	32	506	1,145
Total Texas	5,500	277	2,326	8,103	2,534	212	1,119	3,865	2,897	113	1,412	4,422
West Virginia	971	343	305	1,619	526	332	259	1,117	453	274	216	943
Wyoming	258	12	75	345	259	16	61	336	421	19	32	472
United States	24,273	a2,274	a7,364	a33,911	14,666	a2,111	a5,160	a21,937	17,333	a2,024	a5,332	a24,689

a California gas and dry wells not reported.

Wells drilled monthly in the United States, 1921–22, by States.[a]

Pennsylvania and New York.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Percentage of total wells drilled.	Estimated average initial daily production per well (barrels).
1921.															
Oil	174	183	145	119	154	145	103	88	75	99	129	151	1,565	77.6	3.4
Gas	12	18	18	11	13	24	26	18	5	15	24	24	208	10.3	.....
Dry	22	36	22	18	24	26	17	17	15	14	17	16	244	12.1	.....
	208	237	185	148	191	195	146	123	95	128	170	191	2,017	100.0	.....
1922.															
Oil	126	127	122	161	190	220	219	256	209	243	225	164	2,262	80.6	6.2
Gas	18	22	15	25	28	22	15	31	26	23	26	19	270	9.6	.....
Dry	14	12	25	17	19	22	34	29	31	28	21	22	274	9.8	.....
	158	161	162	203	237	264	268	316	266	294	272	205	2,806	100.0	.....

a Oil and Gas Journal, Standard Oil Bulletin, and American Petroleum Institute.

Wells drilled monthly in the United States, 1921–22, by States—Continued.

West Virginia.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Percentage of total wells drilled.	Estimated average initial daily production per well (barrels).
1921.															
Oil	73	74	63	55	46	40	34	32	22	27	27	33	526	47.1	14.7
Gas	39	31	44	34	15	16	22	26	27	26	24	28	332	29.7	.....
Dry	21	30	25	28	27	26	17	21	18	11	19	16	259	23.2	.....
	133	135	132	117	88	82	73	79	67	64	70	77	1,117	100.0	.....
1922.															
Oil	31	36	37	37	41	34	44	38	33	42	51	29	453	48.0	11.4
Gas	21	25	18	16	14	17	24	31	23	31	20	34	274	29.1	.....
Dry	16	18	18	12	19	19	15	24	12	25	19	19	216	22.9	.....
	68	79	73	65	74	70	83	93	68	98	90	82	943	100.0	.....

Kentucky.

1921.															
Oil	175	227	180	153	195	267	148	150	94	94	103	149	1,935	78.4	20.9
Gas	4	3	5	1	2	3	11	3	10	7	10	5	64	2.6	.....
Dry	25	17	15	10	28	102	57	75	46	33	26	35	469	19.0	.....
	204	247	200	164	225	372	216	228	150	134	139	189	2,468	100.0	.....
1922.															
Oil	159	139	140	171	158	150	150	157	135	124	171	136	1,790	78.9	18.1
Gas	2	5	2	7	10	3	3	11	8	7	6	5	69	3.1	.....
Dry	14	28	37	53	30	31	22	41	45	14	62	32	409	18.0	.....
	175	172	179	231	198	184	175	209	188	145	239	173	2,268	100.0	.....

Tennessee.

1921.															
Oil	....	3	1	5	....	1	....	7	....	....	....	....	17	54.9	22.9
Gas	....	....	....	1	....	....	....	....	....	....	....	....	1	3.2	.....
Dry	....	....	....	2	....	6	....	3	....	....	2	....	13	41.9	.....
	....	3	1	8	....	7	....	10	....	....	2	....	31	100.0	.....
1922.															
Oil	....	9	3	1	....	....	....	3	....	....	....	....	16	50.0	47.0
Gas	....	1	....	....	....	....	....	....	....	....	....	....	1	3.1	.....
Dry	....	11	1	....	....	....	....	2	....	....	1	....	15	46.9	.....
	....	21	4	1	....	....	....	5	....	....	1	....	32	100.0	.....

Ohio.

1921.															
Southeastern and central:															
Oil	109	105	68	66	71	100	79	49	42	55	70	84	898	49.0	12.7
Gas	17	30	37	13	18	16	43	26	56	60	34	55	405	22.0	.....
Dry	60	57	48	39	48	50	45	30	42	42	36	34	531	29.0	.....
	186	192	153	118	137	166	167	105	140	157	140	173	1,834	100.0	.....
Northwestern:															
Oil	39	54	42	31	28	39	31	20	20	12	30	26	372	80.7	17.6
Gas	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....
Dry	2	6	16	9	10	13	6	9	4	2	3	9	89	19.3	.....
	41	60	58	40	38	52	37	29	24	14	33	35	461	100.0	.....
Total Ohio	227	252	211	158	175	218	204	134	164	171	173	208	2,295	.....	.....

Wells drilled monthly in the United States, 1921–22, by States—Continued.

Ohio—Continued.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Percentage of total wells drilled.	Estimated average initial daily production per well (barrels).
1922.															
Southeastern and central:															
Oil	62	83	63	67	96	103	100	93	118	94	99	68	1,046	50.4	9.8
Gas	47	34	22	35	29	24	25	42	72	41	64	47	482	23.3	.....
Dry	40	41	30	40	37	47	36	69	63	42	58	43	546	26.3	.....
	149	158	115	142	162	174	161	204	253	177	221	158	2,074	100.0	.....
Northwestern:															
Oil	23	21	22	13	36	41	55	55	54	37	43	49	449	86.0	16.5
Gas	....	1	1	1	....	....	....	1	1	....	4	3	12	2.3	.....
Dry	3	4	8	7	1	2	3	11	10	2	5	5	61	11.7	.....
	26	26	31	21	37	43	58	67	65	39	52	57	522	100.0	.....
Total Ohio	175	184	146	163	199	217	219	271	318	216	273	215	2,596	.....	.....

Indiana.

1921.															
Northeastern:															
Oil	10	7	24	11	15	14	8	16	7	....	7	4	123	80.9	15.6
Gas	....	....	....	....	....	....	....	1	....	....	....	....	1	.7	.....
Dry	2	3	5	2	2	....	2	7	....	3	2	....	28	18.4	.....
	12	10	29	13	17	14	10	24	7	3	9	4	152	100.0	.....
Southwestern:															
Oil	15	10	12	15	11	18	9	4	5	6	4	5	114	69.1	34.3
Gas	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
Dry	2	2	1	5	6	8	10	5	6	1	4	1	51	30.9	.....
	17	12	13	20	17	26	19	9	11	7	8	6	165	100.0	.....
Total Indiana	29	22	42	33	34	40	29	33	18	10	17	10	317	.....	.....
1922.															
Northeastern:															
Oil	3	3	3	5	6	8	15	13	12	13	19	6	106	88.4	13.5
Gas	....	....	....	....	....	....	....	1	....	....	....	....	1	.8	.....
Dry	1	....	1	2	....	....	3	....	2	3	....	1	13	10.8	.....
	4	3	4	7	6	8	18	14	14	16	19	7	120	100.0	.....
Southwestern:															
Oil	9	3	11	5	5	5	5	3	8	3	5	2	64	57.7	29.4
Gas	1	....	2	....	....	....	....	....	1	....	1	....	5	4.5	.....
Dry	3	3	3	3	4	4	4	2	4	1	7	4	42	37.8	.....
	13	6	16	8	9	9	9	5	13	4	13	6	111	100.0	.....
Total Indiana	17	9	20	15	15	17	27	19	27	20	32	13	231	.....	.....

Illinois.

1921.															
Oil	14	22	22	12	16	24	10	11	9	8	10	7	165	61.8	27.2
Gas	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....
Dry	7	3	6	13	17	14	7	8	5	10	9	3	102	38.2	.....
	21	25	28	25	33	38	17	19	14	18	19	10	267	100.0	.....
1922.															
Oil	8	8	18	11	23	35	26	30	34	24	20	15	252	73.9	23.4
Gas	1	....	....	....	....	....	....	....	....	1	....	....	2	.6	.....
Dry	11	6	4	3	15	8	6	2	16	3	7	6	87	25.5	.....
	20	14	22	14	38	43	32	32	50	28	27	21	341	100.0	.....

Wells drilled monthly in the United States, 1921–22, by States—Continued.

Arkansas.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Percentage of total wells drilled.	Estimated average initial daily production per well (barrels).
1921.															
Oil	1	2	3	8	34	59	88	77	82	69	68	67	558	86.4	914.9
Gas	1	....	7	10	4	1	4	6	3	2	1	3	42	6.5	.....
Dry	5	....	2	2	5	1	1	5	7	8	6	4	46	7.1	.....
	7	2	12	20	43	61	93	88	92	79	75	74	646	100.0	.....
1922.															
Oil	64	68	68	73	40	33	31	22	28	25	77	64	593	81.2	729.8
Gas	6	5	3	2	2	3	3	5	5	1	3	8	46	6.3	.....
Dry	18	4	3	4	4	8	15	16	3	8	5	3	91	12.5	.....
	88	77	74	79	46	44	49	43	36	34	85	75	730	100.0	.....

Kansas.

1921.															
Oil	162	59	123	91	76	98	68	36	27	37	30	106	913	66.2	104.9
Gas	33	1	13	9	3	7	4	8	11	4	1	19	113	8.2	.....
Dry	58	18	46	44	30	32	23	20	12	22	21	28	354	25.6	.....
	253	78	182	144	109	137	95	64	50	63	52	153	1,380	100.0	.....
1922.															
Oil	72	59	98	102	99	100	131	108	99	53	76	60	1,057	64.5	70.4
Gas	5	5	7	5	2	1	6	3	17	9	10	16	86	5.2	.....
Dry	25	25	38	35	37	33	75	45	63	38	39	44	497	30.3	.....
	102	89	143	142	138	134	212	156	179	100	125	120	1,640	100.0	.....

Oklahoma.

1921.															
Oil	505	406	328	269	377	360	319	218	197	184	184	198	3,545	62.0	166.2
Gas	82	82	66	34	59	56	54	47	37	46	44	53	660	11.6	.....
Dry	161	178	158	97	144	158	143	121	98	88	78	85	1,509	26.4	.....
	748	666	552	400	580	574	516	386	332	318	306	336	5,714	100.0	.....
1922.															
Oil	241	221	352	344	338	430	550	421	403	312	304	233	4,149	67.5	286.9
Gas	43	38	27	13	30	50	49	58	57	53	82	71	571	9.3	.....
Dry	94	70	83	112	116	101	146	150	123	132	165	136	1,428	23.2	.....
	378	329	462	469	484	581	745	629	583	497	551	440	6,148	100.0	.....

Louisiana.

1921.															
Northern:															
Oil	69	49	41	35	13	7	14	7	19	8	24	41	327	57.6	590.1
Gas	7	6	8	6	3	4	3	2	5	4	3	4	55	9.7	.....
Dry	30	41	29	18	9	7	9	1	11	6	11	14	186	32.7	.....
	106	96	78	59	25	18	26	10	35	18	38	59	568	100.0	.....
Coastal:															
Oil	9	9	7	3	3	3	3	1	1	....	4	3	46	40.7	102.9
Gas	....	....	....	....	....	....	....	....	....	....	1	....	1	.9	.....
Dry	4	6	6	7	10	2	6	4	3	4	3	11	66	58.4	.....
	13	15	13	10	13	5	9	5	4	4	8	14	113	100.0	.....
Total Louisiana	119	111	91	69	38	23	35	15	39	22	46	73	681	.....	.....

Wells drilled monthly in the United States, 1921–22, by States—Continued.

Louisiana—Continued.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Percentage of total wells drilled.	Estimated average initial daily production per well (barrels.)
1922.															
Northern:															
Oil	48	56	70	103	117	116	108	104	51	15	23	16	827	78.5	450.9
Gas	3	5	3	5	2	5	1	8	6	15	5	9	67	6.3	.....
Dry	6	16	6	14	9	13	12	23	18	18	14	11	160	15.2	.....
	57	77	79	122	128	134	121	135	75	48	42	36	1,054	100.0	.....
Coastal:															
Oil	9	5	5	4	6	2	7	4	3	5	3	8	61	71.8	186.2
Gas	....	....	1	....	....	1	....	....	....	....	....	....	2	2.3	.....
Dry	2	4	2	1	1	1	3	....	5	....	1	2	22	25.9	.....
	11	9	8	5	7	4	10	4	8	5	4	10	85	100.0	.....
Total Louisiana	68	86	87	127	135	138	131	139	83	53	46	46	1,139	.....	.....

Texas.

1921.															
Northern and central:															
Oil	282	320	238	189	228	172	124	106	92	77	102	122	2,052	68.8	279.5
Gas	18	22	21	21	21	14	17	16	10	5	5	4	174	5.8	.....
Dry	95	91	74	72	75	60	61	41	52	36	44	57	758	25.4	.....
	395	433	333	282	324	246	202	163	154	118	151	183	2,984	100.0	.....
Coastal:															
Oil	75	48	54	54	47	30	21	25	21	25	35	47	482	54.7	984.1
Gas	4	4	3	7	7	....	....	3	3	....	2	5	38	4.3	.....
Dry	34	40	31	38	45	20	23	19	29	25	31	26	361	41.0	.....
	113	92	88	99	99	50	44	47	53	50	68	78	881	100.0	.....
Total Texas	508	525	421	381	423	296	246	210	207	168	219	261	3,865	.....	.....
1922.															
Northern and central:															
Oil	170	201	175	203	193	216	170	236	166	194	172	194	2,290	69.9	440.3
Gas	1	4	9	6	4	4	8	8	10	6	11	10	81	2.5	.....
Dry	57	54	68	77	57	94	63	82	63	132	61	98	906	27.6	.....
	228	259	252	286	254	314	241	326	239	332	244	302	3,277	100.0	.....
Coastal:															
Oil	52	32	56	59	61	53	47	56	50	53	50	38	607	53.0	870.1
Gas	....	4	....	....	5	1	6	9	4	....	3	....	32	2.8	.....
Dry	43	53	33	45	55	48	40	41	39	26	40	43	506	44.2	.....
	95	89	89	104	121	102	93	106	93	79	93	81	1,145	100.0	.....
Total Texas	323	348	341	390	375	416	334	432	332	411	337	383	4,422	.....	.....

Wyoming.

1921.															
Oil	28	21	28	39	19	15	25	16	13	14	22	19	259	77.1	358.5
Gas	2	2	1	1	....	1	2	2	....	1	4	....	16	4.8	.....
Dry	6	4	5	4	6	6	2	7	8	3	6	4	61	18.1	.....
	36	27	34	44	25	22	29	25	21	18	32	23	336	100.0	.....
1922.															
Oil	17	15	24	37	44	38	41	26	62	54	30	33	421	89.2	460.8
Gas	....	....	2	....	1	....	3	2	4	2	2	3	19	4.0	.....
Dry	2	1	2	3	2	....	5	6	3	2	5	1	32	6.8	.....
	19	16	28	40	47	38	49	34	69	58	37	37	472	100.0	.....

Wells drilled monthly in the United States, 1921–22, by States—Continued.

Montana.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Percentage of total wells drilled.	Estimated average initial daily production per well (barrels.)
1921.															
Oil	8	7	2	5	13	4	3	1	14	3	1	....	61	64.9	214.8
Gas	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....
Dry	7	....	1	....	4	....	4	3	12	....	2	....	33	35.1	.....
	15	7	3	5	17	4	7	4	26	3	3	....	94	100.0	.....
1922.															
Oil	4	....	2	....	....	2	5	11	5	9	6	9	53	63.1	207.0
Gas	....	....	....	2	....	2	....	....	....	....	....	....	4	4.8	.....
Dry	3	1	1	1	2	1	1	4	3	6	....	4	27	32.1	.....
	7	1	3	3	2	5	6	15	8	15	6	13	84	100.0	.....

California.

1921.															
Oil	64	60	66	58	59	76	76	83	47	32	38	45	704	(a)	(a)
1922.															
Oil	59	45	58	49	66	68	100	76	97	84	71	64	837	(a)	(a)

a Not reported.

SPECIFIC GRAVITY.

Confusion has existed in regard to the hydrometer scales used by the petroleum industry, and recently the question was taken up by a joint committee composed of representatives of the American Petroleum Institute, the Bureau of Mines, and the Bureau of Standards, in an attempt to arrive at a satisfactory settlement. The sentiment in the oil industry appeared to be in favor of departing from the modulus 140, used in the standard Baumé hydrometer, and adopting a modified hydrometer scale based on the modulus 141.5. After due consideration the committee agreed to recommend the adoption of the scale based on the modulus 141.5, this scale to be known as the American Petroleum Institute scale and to be used exclusively in the petroleum industry. The accompanying figures were converted from specific gravity to degrees A. P. I. according to tables in Letter Circular 89 of the Bureau of Standards.

The following table was compiled from reports made to the Geological Survey by pipe-line and producing companies, some of which reported in decimals and others in degrees. Doubtless a number of the reporting companies did not know whether the scales used in reporting degrees were based on modulus 140 or 141.5, and accordingly the column headed "Degrees A. P. I." is questioned.

Estimated average specific gravity of crude petroleum from certain districts, 1922.

District or grade.	Specific gravity.	Degrees A.P.I.(?)
Alaska: Katalla	0.806	44.0
Arkansas:		
El Dorado	.855	34.0
Smackover (range 18° to 29°)	.934	20.0
Stephens	.868	31.5
California:		
Coalinga	.941	18.9
Coyote	.908	24.3
Elk Hills	.919	22.5
Fullerton	.924	21.7
Huntington-Newport	.901	25.6
Kern River	.973	14.0
Long Beach	.900	25.8
Los Angeles	.967	14.8
Lost Hills-Belridge	.901	25.5
McKittrick	.967	14.8
Midway-Sunset	.924	21.7
Montebello	.915	23.2
Redondo-Torrance	.930	20.7
Richfield	.918	22.7
Santa Fe Springs	.860	33.0
Santa Maria	.954	16.9
Summerland	.979	13.0
Ventura-Newhall	.875	30.2
Watsonville	.953	17.0
Wheeler Ridge	.902	25.3
Whittier	.940	19.1
Colorado:		
Boulder	.825	40.0
Florence	.869	31.3
Rangely	.804	44.5
Illinois:		
"Illinois"	.855	34.0
Plymouth	.850	35.0
Princeton	.855	34.0
Waterloo	.876	30.0
Indiana:		
Northeastern	.846	35.8
Southwestern	.865	32.0
Kansas:		
Augusta-Eldorado	.843	36.3
Fox-Bush	.830	39.0
Iola	.940	19.0
Moran	.887	28.0
Peabody-Elbing	.838	37.4
Smock-Sluss	.840	37.0
Teeter-Sallyards	.843	36.4
Virgil	.830	38.9
Kentucky:		
Ragland	.903	25.2
Ravenna	.828	39.5
Rodemer	.882	29.0
Scottsville	.850	35.0
"Somerset"	.833	38.3
Warren County	.845	36.0
Louisiana:		
Northern—		
Bellevue	.940	19.0
Bossier	.902	25.3
Bull Bayou	.829	39.3
Caddo (light)	.829	39.1
Caddo (heavy)	.911	23.9
Crichton	.822	40.7
De Soto	.824	40.3
Haynesville	.851	34.7
Homer	.846	35.7
Coastal—		
Edgerley	.928	21.0
Jennings	.905	24.8
Vinton	.939	19.2
Montana:		
Cat Creek	.784	49.0
Elk Basin	.811	43.0
Sunburst	.865	32.0
New York	.816	42.0
Ohio:		
Cleveland	0.834	38.2
Lima	.843	36.3
Macksburg	.812	42.8
Oklahoma:		
Bartlesville	.858	33.5
Beggs	.834	38.1
Billings	.820	41.0
Blackwell	.835	38.0
Boynton	.830	39.0
Bristow	.850	35.0
Burbank	.837	37.5
Cement	.871	31.0
Cleveland	.850	35.0
Cushing	.830	39.0
Duncan	.845	36.0
Garber	.814	42.4
Glenn	.856	33.9
Healdton	.875	30.2
Hewitt	.856	33.9
Lyons	.828	39.5
Okmulgee	.834	38.1
Ponca-Mervine	.825	40.0
Tonkawa	.816	42.0
Walters	.871	31.0
Yale-Jennings-Quay	.840	37.0
Pennsylvania:		
Franklin	.879	29.5
"Pennsylvania"	.816	42.0
Tennessee	.830	39.0
Texas:		
Northern and central—		
Breckenridge	.835	37.9
Burkburnett	.836	37.8
Corsicana (light)	.850	35.0
Corsicana (heavy)	.907	24.5
Currie	.814	42.4
Electra	.833	38.3
Holliday	.830	39.0
Iowa Park	.830	39.0
Mexia	.842	36.5
Mirando	.934	20.0
Petrolia	.835	38.0
Pioneer	.816	42.0
Ranger	.837	37.6
Somerset	.860	33.0
Coastal—		
Batson	.930	20.6
Blue Ridge	.882	29.0
Damon Mound	.925	21.5
Goose Creek	.910	24.0
Hull	.922	22.0
Humble	.915	23.2
Orange	.918	22.7
Pierce Junction	.918	22.6
Saratoga	.922	21.9
Sourlake	.924	21.7
Spindletop	.918	22.7
West Columbia	.917	22.8
West Virginia:		
Cabell	.829	39.3
Cabin Creek	.788	48.0
"Pennsylvania"	.809	43.4
Wyoming:		
Big Muddy	.861	32.8
Elk Basin	.811	43.0
Ferris and Wertz	.830	39.0
Grass Creek	.803	44.8
Greybull-Torchlight	.793	47.0
Hamilton Dome	.904	25.0
Lance Creek	.817	41.8
Lander	.916	23.0
Mule Creek	.864	32.2
Osage	.830	39.0
Pilot Butte	.850	35.0
Rock Creek	.839	37.1
Salt Creek	.840	37.0

PRODUCTION AND ROYALTIES UNDER FEDERAL CONTROL.

Production and royalty value of crude petroleum produced on Government lands in 1920–1922, under the operation of the leasing act of February 25, 1920.

[Reported by the U. S. Bureau of Mines.]

State and land office.	1920			1921			1922		
	Production (barrels).	Royalty.		Production (barrels).	Royalty.		Production (barrels).	Royalty.	
		Barrels.	Value.		Barrels.	Value.		Barrels.	Value.
California:									
Los Angeles	384,861.20	58,415.91	$124,860.68	796,218.31	113,577.90	$228,691.69	1,343,049.77	197,437.49	$297,722.99
Visalia, outside naval reserves	595,916.61	82,978.07	139,098.39	2,075,701.56	327,705.70	439,761.85	3,209,204.64	520,195.90	501,424.19
Visalia, inside naval reserves	671,365.40	110,149.21	245,641.11	2,038,831.58	394,885.10	707,452.93	7,167,643.13	1,842,891.83	2,194,214.65
	1,652,143.21	251,543.19	509,600.18	4,910,751.45	836,168.70	1,375,906.47	11,719,897.54	2,560,525.22	2,993,361.83
Louisiana: Baton Rouge				4,686.36	313.36	715.31			
Montana: Lewistown				831,237.11	52,533.89	69,752.35	1,962,449.80	109,263.85	243,593.18
Colorado: Glenwood Springs							199.00	39.79	35.85
Wyoming:									
Cheyenne				1,561.52	195.19	227.16	78,339.42	5,770.65	4,235.59
Douglas, outside naval reserves	981,315.62	209,721.43	576,733.63	5,708,820.69	1,181,672.12	1,426,134.73	14,233,952.20	2,964,524.61	3,250,956.81
Douglas, inside naval reserves							37,243.29	6,894.88	9,604.79
Lander	83,420.95	10,652.97	27,934.27	48,163.63	6,597.14	12,424.36	135,450.56	15,946.87	16,101.80
Newcastle				14,924.10	1,927.30	2,742.97	34,792.82	3,776.36	6,328.27
	1,064,736.57	220,374.40	604,667.90	5,773,469.94	1,190,391.75	1,441,529.22	14,519,778.29	2,996,913.37	3,287,227.26
	2,716,879.78	471,917.59	1,114,268.08	11,520,144.86	2,079,407.70	2,887,903.35	28,202,324.63	5,666,742.23	6,524,218.12

Royalty receipts from production of oil and gas and bonuses paid for sale of leases on Indian reservations, fiscal years ending June 30, 1920–1922.

[From Office of Indian Affairs.]

Reservation.	1920			1921			1922		
	Oil and gas land leased during year (acres).	Receipts.		Oil and gas land leased during year (acres).	Receipts.		Oil and gas land leased during year (acres).	Receipts.	
		Bonus from sale of leases.	Royalty from production.		Bonus from sale of leases.	Royalty from production.		Bonus from sale of leases.	Royalty from production.
Five Civilized Tribes:									
Oil	329,580	$982,132	$3,052,089	143,446	$664,797	$3,042,080	130,415	$689,126	$2,247,739
Gas			279,053						148,880
Crow:									
Oil							47,757	4,371	
Gas									
Kiowa:									
Oil	14,364	339,800	21,567	13,563	129,418	46,200	7,390	27,797	25,000
Gas			1,200						1,500
Osage:									
Oil	96,146	11,965,800	8,079,788	62,795	8,552,850	10,267,544	102,353	22,101,250	8,542,990
Gas			972,763			1,041,202			692,702
Pawnee:									
Oil	9,410	11,653	66,909	5,057	10,434	547,184	8,099	13,839	32,915
Gas						900			
Ponca and Atoe:									
Oil	10,630	11,594	147,264	6,177	6,177	140,006	57,284	105,420	58,689
Gas			3,280			2,946			2,152
Seger: Oil							6,533	16,557	
Shawnee:									
Oil	2,838	6,498	8,529	2,321	15,301	11,585	3,800	10,130	6,575
Gas									
Shoshone:									
Oil	496	734	15,683	5,779	8,876	13,212	3,120	2,840	8,000
Gas	Tribal.								
	463,464	13,318,211	12,648,125	239,138	9,387,853	15,112,859	366,751	22,971,330	11,767,142

SUMMARY OF REFINERY STATISTICS.

The following table was compiled from "Petroleum refinery statistics for 1923," published by the U. S. Bureau of Mines:

Refinery statistics, 1918–1922.

[Thousands of barrels of 42 U. S. gallons.]

	Crude oil.	Gasoline.	Kerosene.	Gas and fuel oil.	Lubricants.
Production:					
1918		85,007	43,461	174,319	20,035
1919		94,235	55,753	181,602	20,161
1920		116,251	55,240	210,987	24,922
1921		122,704	46,313	230,091	20,901
1922		147,672	54,913	254,910	23,304
Imports:					
1918		307	(a)	(a)	(a)
1919		203	(a)	(a)	(a)
1920		964	(a)	(a)	(a)
1921		900	(a)	(a)	(a)
1922		1,479	b 3	b 2,947	b 43
Exports: c					
1918		13,545	11,820	29,637	6,165
1919		9,098	23,537	16,487	6,598
1920		15,637	20,878	22,079	9,643
1921		13,134	18,016	22,676	6,937
1922		14,157	21,489	18,479	7,940
Consumption:					
1918		74,506	34,442	142,751	13,823
1919		81,781	33,188	163,802	13,599
1920		101,207	33,083	185,972	14,726
1921		107,524	29,537	195,656	12,626
1922		127,907	34,855	240,010	14,955
Stocks at refineries (at end of year):					
1918	15,750	7,079	9,050	15,691	3,306
1919	13,143	10,638	8,079	17,003	3,269
1920	21,261	11,009	9,359	19,938	3,822
1921	26,562	13,954	8,119	31,697	5,161
1922	33,805	21,043	6,692	31,065	5,613

a No data available.
b October-December only.
c Including shipments to Alaska, Hawaii, and Porto Rico.

OIL SHALE.

Slow progress is the record of the domestic oil-shale industry in 1922. Overproduction of petroleum and general low prices afforded little incentive to the oil-shale operator, and no sales of oil shale or of shale oil in the United States during the year have been reported to the Geological Survey. Development work progressed on oil-shale lands in connection with annual assessments, experimental work was continued in research laboratories and shale-oil plants, and small quantities of shale oil are reported to have been produced in California and at Elko, Nev., details of which are not yet available for publication. The following reports of general interest have been published recently:

Gavin, M. J., Oil shale, an historical, technical, and economic study: Bur. Mines Bull. 210, 1922.

Winchester, D. E., Oil shale of the Rocky Mountain region: U. S. Geol. Survey Bull. 729, 1923.

These reports contain valuable bibliographies. The oil shales of Indiana are described in a comprehensive report by John R. Reeves, published in mimeographed form in 1923; and the proceedings of the National Oil Shale Conference in connection with the annual meeting of the American Mining Congress at Cleveland in October, 1922, are given in the Colorado School of Mines Quarterly for October, 1922, and January, 1923.

Foreign production of oil shale, 1919-1922, in metric tons.

Country.	1919	1920	1921	1922
Austria (ichthyolic shale)[a]	1,003	1,095	1,160	715
Australia:				
New South Wales[b]	25,861	21,341	33,009	23,844
Tasmania[c]	610	142	882	41
Esthonia[d]	9,632	45,671	94,773	(*f*)
France	*e*49,127	*e*69,000	*e*66,237	(*f*)
Italy:[g]				
Ichthyolic shale	1,000	300	1,830	600
Bituminous shale	10,563	16,325	3,030	5,476
Sweden[h]	.....	.....	328	353
United Kingdom:[i]				
Scotland	2,807,615	2,886,455	1,896,860	2,645,790
England	620	1,750	.....	.....

[a] Austrian Ministry for Trade and Craft, Industry, and Works.
[b] New South Wales Dept. Mines Ann. Rept.
[c] Tasmania Sec. for Mines Ann. Rept.
[d] Petroleum Times, London, Jan. 27, 1923, p. 123.
[e] Statistique de l'industrie minérale, Paris, 1921.
[f] Not available.
[g] Rivista del servizio minerario.
[h] Bergshantering; Sveriges officiella Statistik.
[i] Great Britain Sec. for Mines Rept.

PUBLICATIONS OF THE U. S. GEOLOGICAL SURVEY RELATING TO PETROLEUM, NATURAL GAS, AND OIL SHALE.

Publications marked by an asterisk (*) in the following list can no longer be obtained from the Geological Survey, but some of these can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

ANNUAL REPORTS.

*Eighth Annual Report, for 1886–87, Part II, The Trenton limestone as a source of petroleum and inflammable gas in Ohio and Indiana, by Edward Orton, pp. 475–662, pls. liv.–lx.

*Eleventh Annual Report, for 1889–90, Part I, The natural gas field of Indiana, by A. J. Phinney, pp. 579–742, pls. lxii–lxvi.
*Nineteenth Annual Report, for 1897–98, Part VI (continued), Mineral Resources of the United States, 1897.
*Twenty-second Annual Report, for 1900–1901, Part III, The Gaines oil field of northern Pennsylvania, by M. L. Fuller, pp. 573–627, pls. xxxvi–xliii.

PROFESSIONAL PAPERS.

*53. Geology and water resources of the Bighorn Basin, Wyo., by C. A. Fisher, 1906. 72 pp., 16 pls.
*56. Geography and geology of a portion of southwestern Wyoming, with special reference to coal and oil, by A. C. Veatch. 1907. 178 pp., 26 pls.
*65. Geology and water resources of the northern portion of the Black Hills and adjoining regions in South Dakota and Wyoming, by N. H. Darton. 1909. 105 pp. 24 pls.
85. Shorter contributions to general geology, 1913; David White, chief geologist. 1914.
(b) The mud lumps at the mouths of the Mississippi, by E. W. Shaw, pp. 11–27, pls. i–iii.
*93. Geology of the Navajo country—a reconnaissance of parts of Arizona, New Mexico, and Utah, by H. E. Gregory. 1917. 161 pp., 34 pls.
*116. The Sunset-Midway oil field, Calif., Part I, Geology and oil resources, by R. W. Pack. 1920. 179 pp., 45 pls.
*117. The Sunset-Midway oil field, Calif., Part II, Geochemical relations of the oil, gas, and water, by G. S. Rogers. 1919. 103 pp., 2 pls.
*120. Shorter contributions to general geology, 1918; David White, chief geologist. 1919.
*(b) Geology of northeastern Montana, by A. J. Collier, pp. 17–39, pls. i–vi.
*(h) A contribution to the geology of northeastern Texas and southern Oklahoma, by L. W. Stephenson, pp. 129–163, pls. xvii–xxx.
121. Helium-bearing natural gas, by G. S. Rogers. 1921. 113 pp., 4 pls.
126. Geology of the Coastal Plain region of Texas, by Alexander Deussen. 1924. 139 pp., 36 pls.
128. Shorter contributions to general geology, 1920; David White, chief geologist. 1921.
(c) The origin of the faults, anticlines, and buried "granite ridge" of the northern part of the Mid-Continent oil and gas field, by A. E. Fath, pp. 75–84, pls. xii–xiv.
129. Shorter contributions to general geology, 1921; David White, chief geologist. 1922.
*(a) Lithologic subsurface correlation in the "Bend series" of north-central Texas, by M. I. Goldman, pp. 1–22, pl. i.
131. Shorter contributions to general geology, 1922; David White, chief geologist. 1923.
(d) A geologic reconnaissance in the Gulf Coastal Plain of Texas near the Rio Grande, by A. C. Trowbridge, pp. 85–117, pls. xxvii–xxxiii.

BULLETINS.

*184. Oil and gas fields of the western interior and northern Texas coal measures and of the Upper Cretaceous and Tertiary of the western Gulf coast, by G. I. Adams. 1901. 64 pp., 10 pls.
*198. The Berea grit oil sand in the Cadiz quadrangle, Ohio, by W. T. Griswold. 1902. 43 pp., 1 pl.
*212. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by C. W. Hayes and William Kennedy. 1903. 174 pp., 11 pls.
*213. Contributions to economic geology, 1902; S. F. Emmons and C. W. Hayes, geologists in charge. 1903.
The petroleum fields of California, by G. H. Eldridge, pp. 306–321.
The Boulder, Colo., oil field, by N. M. Fenneman, pp. 322–332.
Asphalt, oil, and gas in southwestern Indiana, by M. L. Fuller, pp. 333–334.
Structural work during 1901 and 1902 in the eastern Ohio oil fields, by W. T. Griswold, pp. 336–344.
Oil fields of the Texas-Louisiana Gulf Coastal Plain, by C. W. Hayes, pp. 345–352.

*225. Contributions to economic geology, 1903; S. F. Emmons and C. W. Hayes, geologists in charge. 1904.
The petroleum fields of Alaska and the Bering River coal fields, by G. C. Martin, pp. 365–382.
Structure of the Boulder oil field, Colo., with records for the year 1903, by N. M. Fenneman, pp. 383–391.
Hyner gas pool, Clinton County, Pa., by M. L. Fuller, pp. 392–395.
Oil and gas fields of eastern Greene County, Pa., by R. W. Stone, pp. 396–412.

*238. Economic geology of the Iola quadrangle, Kans., by G. I. Adams, Erasmus Haworth, and W. R. Crane. 1904. 83 pp., 11 pls.

*250. The petroleum fields of the Pacific coast of Alaska, with an account of the Bering River coal deposits, by G. C. Martin. 1905. 64 pp., 7 pls.

*256. Mineral resources of the Elders Ridge quadrangle, Pa., by R. W. Stone. 1905. 86 pp., 12 pls.

*259. Report on progress of investigations of mineral resources of Alaska in 1904, by A. H. Brooks and others. 1905. 196 pp., 3 pls.

*260. Contributions to economic geology, 1904; S. F. Emmons and C. W. Hayes, geologists in charge. 1905.
The Florence, Colo., oil field, by N. M. Fenneman, pp. 436–440.
Notes on the geology of the Muscogee oil field, Ind. T. [Okla.], by J. A. Taff and M. K. Shaler, pp. 441–445.
Oil and gas of the Independence quadrangle, Kans., by F. C. Schrader and Erasmus Haworth, pp. 446–458.
Oil fields of the Texas-Louisiana Gulf coast, by N. M. Fenneman, pp. 459–467.
Oil and asphalt prospects in Salt Lake basin, Utah, by J. M. Boutwell, pp. 468–479.
Natural gas near Salt Lake City, Utah, by G. B. Richardson, pp. 480–483.
Salt, gypsum, and petroleum in trans-Pecos Texas, by G. B. Richardson, pp. 573–585, pl. iv.

*264. Record of deep-well drilling for 1904, by M. L. Fuller, E. F. Lines, and A. C. Veatch. 1905. 106 pp.

*265. Geology of the Boulder district, Colo., by N. M. Fenneman. 1905. 101 pp., 5 pls.

*279. Economic geology of the Kittanning and Rural Valley quadrangles, Pa., by Charles Butts. 1906. 198 pp., 11 pls.

*282. Oil fields of the Texas-Louisiana Gulf Coastal Plain, by N. M. Fenneman. 1906. 146 pp., 11 pls.

*283. Geology and mineral resources of Mississippi, by A. F. Crider. 1906. 99 pp., 4 pls.

*285. Contributions to economic geology, 1905; S. F. Emmons and E. C. Eckel, geologists in charge. 1906.
Coal and oil in southern Uinta County, Wyo., by A. C. Veatch, pp. 331–353, pls. x–xii.
The Salt Lake oil field, near Los Angeles, Calif., by Ralph Arnold, pp. 357–361.
The Nineveh and Gordon oil sands in western Greene County, Pa., by F. G. Clapp, pp. 362–366.

*286. Economic geology of the Beaver quadrangle, Pa. (southern Beaver and northwestern Allegheny counties), by L. H. Woolsey. 1906. 132 pp., 8 pls.

*296. Economic geology of the Independence quadrangle, Kans., by F. C. Schrader and Erasmus Haworth. 1906. 74 pp., 6 pls.

*298. Record of deep-well drilling for 1905, by M. L. Fuller and Samuel Sanford. 1906. 299 pp.

*300. Economic geology of the Amity quadrangle, eastern Washington County, Pa., by F. G. Clapp. 1907. 145 pp., 8 pls.

*304. Oil and gas fields of Greene County, Pa., by R. W. Stone and F. G. Clapp. 1907. 110 pp., 3 pls.

*309. The Santa Clara Valley, Puente Hills, and Los Angeles oil districts, southern California, by G. H. Eldridge and Ralph Arnold. 1907. 266 pp., 41 pls.

*314. Report on progress of investigations of mineral resources of Alaska in 1906, by A. H. Brooks and others. 1907.
Petroleum at Controller Bay, by G. C. Martin, pp. 89–103.

*317. Preliminary report on the Santa Maria oil district, Santa Barbara County, Calif., by Ralph Arnold and Robert Anderson. 1907. 69 pp., 2 pls. (See Bulletin 322.)

*318. Geology of oil and gas fields in Steubenville, Burgettstown, and Claysville quadrangles, Ohio, W. Va., and Pa., by W. T. Griswold and M. J. Munn. 1907. 196 pp., 13 pls.

*321. Geology and oil resources of the Summerland district, Santa Barbara County, Calif., by Ralph Arnold. 1907. 93 pp., 17 pls.

*322. Geology and oil resources of the Santa Maria oil district, Santa Barbara County, Calif., by Ralph Arnold and Robert Anderson. 1907. 161 pp., 26 pls.

*335. Geology and mineral resources of the Controller Bay region, Alaska, by G. C. Martin. 1908. 141 pp., 10 pls.

*340. Contributions to economic geology, 1907, Part I, Metals and nonmetals except fuels; C. W. Hayes and Waldemar Lindgren, geologists in charge. 1908.

*(c) Mineral resources of northeastern Oklahoma, by C. E. Siebenthal, pp. 187–228, pl. ii.

*(f) The Miner ranch oil field, Contra Costa County, Calif., by Ralph Arnold, pp. 339–342.
Petroleum in southern Utah, by G. B. Richardson, pp. 343–347.
Gas fields of the Bighorn Basin, Wyo., by C. W. Washburne, pp. 348–363, pl. iii.
The Labarge oil field, central Uinta County, Wyo., by A. R. Schultz, pp. 364–373, pl. iv.

*346. Structure of the Berea oil sand in the Flushing quadrangle, Harrison, Belmont, and Guernsey counties, Ohio, by W. T. Griswold. 1908. 30 pp., 2 pls.

*349. Economic geology of the Kenova quadrangle, Ky., Ohio, and W. Va., by W. C. Phalen. 1908. 158 pp., 6 pls.

*350. Geology of the Rangely oil district, Rio Blanco County, Colo., with a section on the water supply, by H. S. Gale. 1908. 61 pp., 4 pls.

*357. Preliminary report on the Coalinga oil district, Fresno and Kings counties, Calif., by Ralph Arnold and Robert Anderson. 1908. 142 pp., 2 pls. (See Bulletin 398.)

*364. Geology and mineral resources of the Laramie Basin, Wyo. (a preliminary report), by N. H. Darton and C. E. Siebenthal. 1909. 81 pp., 8 pls.

*365. The fractionation of crude petroleum by capillary diffusion, by J. E. Gilpin and M. P. Cram, under the supervision of D. T. Day. 1908. 33 pp.

*381. Contributions to economic geology, 1908, Part II, Mineral fuels; M. R. Campbell, geologist in charge.

*(d) Geology and oil prospects of the Reno region, Nev., by Robert Anderson, pp. 475–489.
Two areas of oil prospecting in Lyon County, western Nevada, by Robert Anderson, pp. 490–493.
Analyses of crude petroleum from Oklahoma and Kansas, by D. T. Day, pp. 494–503.
The Madill oil pool, Okla., by J. A. Taff and W. J. Reed, pp. 504–513, pl. xxiii.
Development in the Boulder oil field, Colo., by C. W. Washburne, pp. 514–516.
The Florence oil field, Colo., by C. W. Washburne, pp. 517–544, pl. xxiv.

*394. Papers on the conservation of mineral resources (reprinted from report of the National Conservation Commission, February, 1909). 1909. 214 pp., 12 pls.

The petroleum resources of the United States, by D. T. Day, pp. 30–50, pls. ii–v.

*398. Geology and oil resources of the Coalinga district, Calif., by Ralph Arnold and Robert Anderson, with a report on the chemical and physical properties of the oils, by I. C. Allen. 1910. 354 pp., 52 pls.

*401. Relations between local magnetic disturbances and the genesis of petroleum, by G. F. Becker. 1909. 24 pp., 1 pl.

*406. Preliminary report on the McKittrick-Sunset oil region, Kern and San Luis Obispo counties, Calif., by Ralph Arnold and H. R. Johnson. 1910. 225 pp., 5 pls.

*415. Coal fields of northwestern Colorado and northeastern Utah, by Hoyt S. Gale. 1910. 265 pp., 22 pls.

*429. Oil and gas in Louisiana, with a brief summary of their occurrence in adjacent States, by G. D. Harris. 1910. 192 pp., 22 pls.

*431. Contributions to economic geology (short papers and preliminary reports), 1909, Part II, Mineral fuels; M. R. Campbell, geologist in charge. 1911.

*(a) Natural gas in North Dakota, by A. G. Leonard, pp. 7–10. pl. i.
The San Juan oil field, San Juan County, Utah, by H. E. Gregory, pp. 11–25, pl. ii.
Gas and oil prospects near Vale, Oreg., and Payette, Idaho, by C. W. Washburne, pp. 26–55, pl. iii.
Gas prospects in Harney Valley, Oreg., by C. W. Washburne, pp. 56–57.
Preliminary report on the geology and the oil prospects of the Cantua-Panoche region, Calif., by Robert Anderson, pp. 58–87.

*438. Geology and mineral resources of the St. Louis quadrangle, Mo.-Ill., by N. M. Fenneman. 1911. 73 pp., 6 pls.

450. Mineral resources of the Llano-Burnet region, Tex., with an account of the pre-Cambrian geology, by Sidney Paige. 1911. 103 pp., 5 pls.

*452. The Lander and Salt Creek oil fields, Wyo.: The Lander oil field, Fremont County, by E. G. Woodruff; The Salt Creek oil field, Natrona County, by C. H. Wegemann. 1911. 87 pp., 12 pls.

*454. Coal, oil, and gas of the Foxburg quadrangle, Pa., by E. W. Shaw and M. J. Munn. 1911. 85 pp., 10 pls.

*456. Oil and gas fields of the Carnegie quadrangle, Pa., by M. J. Munn. 1911. 99 pp., 5 pls.

*467. Geology and mineral resources of parts of the Alaska Peninsula, by W. W. Atwood. 1911. 137 pp., 14 pls.

*471. Contributions to economic geology (short papers and preliminary reports), 1910, Part II, Mineral fuels; M. R. Campbell, geologist in charge. 1912.

*(a) The Campton oil pool, Ky., by M. J. Munn, pp. 9–17, pls. i–ii.
Oil and gas developments in Knox County, Ky., by M. J. Munn, pp. 18–29, pls. iii–iv.
The Fayette gas field, Ala., by M. J. Munn, pp. 30–55, pls. v–vi.
The Powder River oil field, Wyo., by C. H. Wegemann, pp. 56–75, pl. vii.
Geology of the San Juan oil field, Utah, by E. G. Woodruff, pp. 76–104, pls. viii–ix.
Marsh gas along Grand River near Moab, Utah, by E. G. Woodruff, p. 105.
Preliminary report on the geology and possible oil resources of the south end of the San Joaquin Valley, Calif., by Robert Anderson, pp. 106–136, pl. x.

*475. The diffusion of crude petroleum through fuller's earth, with notes on its geologic significance, by J. E. Gilpin and O. E. Bransky. 1911. 50 pp.

*491. The data of geochemistry (second edition) by F. W. Clarke. 1911. 782 pp.

*531. Contributions to economic geology (short papers and preliminary reports). 1911, Part II, Mineral fuels; M. R. Campbell, geologist in charge. 1913.

*(a) The Menifee gas field and the Ragland oil field, Ky., by M. J. Munn, pp. 9–26, pls. i–iv.
*(b) Oil and gas development in north-central Oklahoma, by R. H. Wood, pp. 27–53, pl. v.
*(c) Geology and petroleum resources of the De Beque oil field, Colo., by E. G. Woodruff, pp. 54–68, pl. vi.
*(d) Geologic structure of the Punxsutawney, Curwensville, Houtsdale, Barnesboro, and Patton quadrangles, central Pennsylvania, by G. H. Ashley and M. R. Campbell, pp. 69–89, pls. vii–viii.

*537. The classification of the public lands, by G. O. Smith and others. 1913. 75 pp., 13 pls.

*541. Contributions to economic geology (short papers and preliminary reports), 1912, Part II, Mineral fuels; M. R. Campbell, geologist in charge. 1914.

*(a) Oil and gas in the northern part of the Cadiz quadrangle, Ohio, by D. D. Condit, pp. 9–17, pl. i; Gas from mud lumps at the mouths of the Mississippi, by E. W. Shaw, pp. 19–22.

*(b) Structure of the Fort Smith-Poteau gas field, Ark.-Okla., by C. D. Smith, pp. 23–33, pl. ii; The Glenn oil and gas pool and vicinity, Okla., by C. D. Smith, pp. 34–48, pl. iii.
*(c) The Douglas oil and gas field, Converse County, Wyo., by V. H. Barnett, pp. 49–88, pl. iv; The Shoshone River section, Wyo., by D. F. Hewett, pp. 89–113, pl. v.
*(d) Oil and gas near Green River, Grand County, Utah, by C. T. Lupton, pp. 115–133, pl. vi; Petroleum near Dayton, N. Mex., by G. B. Richardson, pp. 135–140.
*(e) Reconnaissance of the Barstow-Kramer region, Calif., by R. W. Pack, pp. 141–154, pl. vii.

*543. Geology and geography of a portion of Lincoln County, Wyo., by A. R. Schultz. 1914. 141 pp., 11 pls.

*547. Reconnaissance of the Grandfield district, Okla., by M. J. Munn. 1914. 85 pp., 5 pls.

*579. Reconnaissance of oil and gas fields in Wayne and McCreary counties, Ky., by M. J. Munn. 1914. 105 pp., 6 pls.

*581. Contributions to economic geology (short papers and preliminary reports), 1913, Part II, Mineral fuels; M. R. Campbell and David White, geologists in charge. 1915.
*(a) Oil shale of northwestern Colorado and northeastern Utah, by E. G. Woodruff and D. T. Day, pp. 1–21, pl. i.
*(b) Oil and gas in the western part of the Olympic Peninsula, Wash., by C. T. Lupton, pp. 23–81, pl. ii.
*(c) The Moorcroft oil field, Crook County, Wyo., by V. H. Barnett, pp. 83–104, pl. iii; Possibilities of oil in the Big Muddy dome, Converse and Natrona counties, Wyo., by V. H. Barnett, pp. 105–117, pl. iv.
*(d) Geology and oil prospects of Waltham, Priest, Bitterwater, and Peachtree valleys, Calif., by R. W. Pack and W. A. English, pp. 119–160, pl. v.

*590. Reconnaissance of the geology and oil prospects of northwestern Oregon, by C. W. Washburne. 1914. 111 pp., 1 pl.

599. Our mineral reserves—how to make America industrially independent, by G. O. Smith. 1914. 48 pp.

*602. Anticlinal structure in parts of Cotton and Jefferson counties, Okla., by C. H. Wegemann, 1915. 108 pp., 5 pls.

*603. Geology and oil resources of the west border of the San Joaquin Valley north of Coalinga, Calif., by Robert Anderson and R. W. Pack. 1915. 220 pp., 14 pls.

*616. The data of geochemistry (third edition), by F. W. Clarke. 1916. 821 pp.

*619. The Caddo oil and gas field, Louisiana and Texas, by G. C. Matson. 1916. 62 pp., 8 pls.

*621. Contributions to economic geology (short papers and preliminary reports), 1915, Part II, Mineral fuels; M. R. Campbell and David White, geologists in charge. 1916.
*(b) The Healdton oil field, Carter County, Okla., by C. H. Wegemann and K. C. Heald, pp. 13–30, pls. iii-v.
*(c) The Loco gas field, Stephens and Jefferson counties, Okla., by C. H. Wegemann, pp. 31–42, pls. vi-vii.
*(d) The Duncan gas field, Stephens County, Okla., by C. H. Wegemann, pp. 43–50, pls. viii-ix.
*(e) A reconnaissance in Palo Pinto County, Tex., with special reference to oil and gas, by C. H. Wegemann, pp. 51–59.
*(f) Possibilities of oil in the Porcupine dome, Rosebud County, Mont., by C. F. Bowen, pp. 61–70, pl. x.
*(g) The Lawton oil and gas field, Okla., by C. H. Wegemann and R. W. Howell, pp. 71–85, pls. xi-xii.
*(h) Anticlines in the Clinton sand near Wooster, Wayne County, Ohio, by C. A. Bonine, pp. 87–98, pl. xiii.
*(j) A reconnaissance for oil near Quanah, Hardeman County, Tex., by C. H. Wegemann, pp. 109–115, pl. xiv.
*(l) Oil and gas near Basin, Big Horn County, Wyo., by C. T. Lupton, pp. 157–190, pls. xvii-xviii.
*(m) Geology and oil prospects of Cuyama Valley, Calif., by W.A. English, pp. 191–215, pl. xix-xxi.

*(n) Structure of the Berea oil sand in the Summerfield quadrangle, Guernsey, Noble, and Monroe counties, Ohio, by D. D. Condit, pp. 217–231, pls. xxii-xxiii.
*(o) Structure of the Berea oil sand in the Woodsfield quadrangle, Belmont, Monroe, Noble, and Guernsey counties, Ohio, by D. D. Condit, pp. 233–249, pls. xxiv-xxv.

*623. Petroleum withdrawals and restorations affecting the public domain, by M. W. Ball; compilation by L. W. Stockbridge. 1916. 427 pp., 9 pls.

*624. Useful minerals of the United States, compiled by F. C. Schrader, R. W. Stone, and Samuel Sanford. 1916. 412 pp.

*629. Natural gas resources of parts of north Texas: Gas in the area north and west of Fort Worth, by E. W. Shaw; Gas prospects south and southeast of Dallas, by G. C. Matson; with notes on the gas fields of central and southern Oklahoma, by C. H. Wegemann. 1916. 126 pp., 7 pls.

*641. Contributions to economic geology (short papers and preliminary reports), 1916, Part II, Mineral fuels; David White, G. H. Ashley, and M. R. Campbell, geologists in charge. 1917.
*(b) The oil and gas geology of the Foraker quadrangle, Osage County, Okla., by K. C. Heald, pp. 17–47, pls. ii-iii.
*(c) Possibilities of oil and gas in north-central Montana, by Eugene Stebinger, pp. 49–91, pls. iv-vii.
*(d) Structure of the Vicksburg-Jackson area, Miss., with special reference to oil and gas, by O. B. Hopkins, pp. 93–120, pl. viii.
*(e) An anticlinal fold near Billings, Noble County, Okla., by A. E. Fath, pp. 121–138, pl. ix.
*(f) Oil shale in northwestern Colorado and adjacent areas, by D. E. Winchester, pp. 139–198, pls. x–xix.
*(g) Geology of the Upper Stillwater Basin, Stillwater and Carbon counties, Mont., with special reference to coal and oil, by W. R. Calvert, pp. 199–214, pls. xx–xxi.
*(i) Anticlines in central Wyoming, by C. J. Hares, pp. 233–279, pl. xxiii.
*(j) Anticlines in the Blackfeet Indian Reservation, Mont., by Eugene Stebinger, pp. 281–305, pls. xxiv–xxv.
*(l) Oil resources of black shales of the eastern United States, by G. H. Ashley, pp. 311–324.

653. Chemical relations of the oil-field waters in San Joaquin Valley, Calif. (preliminary report), by G. S. Rogers. 1917. 119 pp.

*656. Anticlines in the southern part of the Big Horn Basin, Wyo. (a preliminary report on the occurrence of oil), by D. F. Hewett and C. T. Lupton. 1917. 192 pp., 32 pls.

*658. Geologic structure in the Cushing oil and gas field, Okla., and its relation to the oil, gas, and water, by C. H. Beal. 1917. 64 pp., 11 pls.

*661. Contributions to economic geology (short papers and preliminary reports), 1917. Part II, Mineral fuels; David White, G. H. Ashley, and M. R. Campbell, geologists in charge. 1918.
*(a) The Cleveland gas field, Cuyahoga County, Ohio, with a study of rock pressure, by G. S. Rogers, pp. 1–68, pls. i–ii.
*(b) Structure of the northern part of the Bristow quadrangle, Creek County, Okla., with reference to petroleum and natural gas, by A. E. Fath, pp. 69–99, pls. iii–vi.
*(c) The De Soto-Red River oil and gas field, La., by G. C. Matson and O. B. Hopkins, pp. 101–140, pls., vii–x.
(d) The Irvine oil field, Estill County, Ky., by E. W. Shaw, pp. 141–192, pls. xi–xv.
*(e) The Bowdoin dome, Mont., a possible reservoir of oil or gas, by A. J. Collier, pp. 133–209, pl. xvi.
*(f) The Corsicana oil and gas field, Tex., by G. C. Matson and O. B. Hopkins, pp. 211–252, pls. xvii–xxi.
*(g) The Palestine salt dome, Anderson County, Tex., by O. B. Hopkins, pp 253–270; The Brenham salt dome, Washington and Austin counties, Tex., by O. B. Hopkins, pp. 271–280, pls., xxiv–xxv.
*(h) Oil and gas possibilities of the Hatchetigbee anticline, Ala., by O. B. Hopkins, pp. 281–313, pls. xxvi–xxix.
*(i) Phosphatic oil shales near Dell and Dillon, Beaverhead County, Mont., by C. F. Bowen, pp. 315–328 (including index and title-page to volume).

662. Mineral resources of Alaska, report on progress of investigations in 1916, by A. H. Brooks and others.
*(a) The Alaskan mining industry in 1916, by A. H. Brooks, pp. 1–62, pls. i–iv.
*666. Our mineral supplies; H. D. McCaskey and E. F. Burchard, geologists in charge. 1919. 278 pp., 1 pl.
*(dd) Petroleum, by J. D. Northrop. 13 pp.
*670. The Salt Creek oil field, Wyo., by C. H. Wegemann. 1917. 52 pp., 7 pls.
686. Structure and oil and gas resources of the Osage Reservation, Okla., by David White and others. 1922. xvi, 427 pp., 60 pls.
(Separate chapters covering individual townships have been published.)
*688. The oil fields of Allen County, Ky., with notes on the oil geology of adjoining counties, by E. W. Shaw and K. F. Mather. 1919. 126 pp., 10 pls.
*691. Contributions to economic geology (short papers and preliminary reports), 1918, Part II, Mineral fuels; David White, G. H. Ashley, and M. R. Campbell, geologists in charge. 1919.
*(a) The structure of parts of the central Great Plains, by N. H. Darton, pp. 1–26, pls. i–iv.
*(b) Oil shale of the Uinta Basin, northeastern Utah, and Results of dry distillation of miscellaneous shale samples, by D. E. Winchester, pp. 27–55, pls. v–xii.
*(c) Geologic structure of the northwestern part of the Pawhuska quadrangle, Okla., by K. C. Heald, pp. 57–100, pls. xiii–xv.
*(d) Geology and oil and gas prospects of the Lake Basin field, Mont., by E. T. Hancock, pp. 101–147, pls. xvi–xxiii.
*(e) Oil and gas geology of the Birch Creek-Sun River area, northwestern Montana, by Eugene Stebinger, pp. 149–184, pl. xxiv.
*(f) Anticlines in a part of the Musselshell Valley, Musselshell, Meagher, and Sweet Grass counties, Mont., by C. F. Bowen, pp. 185–209, pl. xxv.
(g) The Nesson anticline, Williams County, N. Dak., by A. J. Collier, pp. 211–217, pl. xxvi.
*(h) Geology and oil prospects of the Salinas Valley-Parkfield area, Calif., by W. A. English, pp. 219–250, pls. xxvii–xxviii.
*(i) The Santo Tomas cannel coal, Webb County, Tex., by G. H. Ashley, pp. 251–270, pls. xxix–xxxii.
*(j) Asphalt deposits and oil conditions in southwestern Arkansas, by H. D. Miser and A. H. Purdue, pp. 271–292, pl. xxxiii.
(m) Structure and oil resources of the Simi Valley, southern California, by W. S. W. Kew, pp. 323–355, i–viii (including title-page, contents, list of illustrations, and index to volume), pls. xli–xliv.
*693. The evaporation and concentration of waters associated with petroleum and natural gas, by R. V. A. Mills and R. C. Wells. 1919. 104 pp., 4 pls.
*695. The data of geochemistry (fourth edition), by F. W. Clarke. 1920. 832 pp.
*702. Oil possibilities in and around Baxter Basin, in the Rock Springs uplift, Sweetwater County, Wyo., by A. R. Schultz. 1920. 107 pp., 17 pls.
705. Conservation through engineering, by F. K. Lane. 1920. 35 pp.
711. Contributions to economic geology (short papers and preliminary reports), 1919, Part II, Mineral fuels; David White and G. H. Ashley, geologists in charge. 1920.
*(a) The Farnham anticline, Carbon County, Utah, by F. R. Clark, pp. 1–13, pls. i–ii.
*(b) Oil shale in western Montana, southeastern Idaho, and adjacent parts of Wyoming and Utah, by D. D. Condit, pp. 15–40, pl. iii.
(d) Oil in the Warm Springs and Hamilton domes, near Thermopolis, Wyo., by A. J. Collier, pp. 61–73, pls. vii–x.
*(e) Gas in the Big Sand Draw anticline, Fremont County, Wyo., by A. J. Collier, pp. 75–83, pl. xi.
*(g) Geology and oil and gas prospects of the Huntley field, Mont., by E. T. Hancock, pp. 105–148, pls. xiv–xviii.
*(h) Anticlines near Maverick Springs, Fremont County, Wyo., by A. J. Collier, pp. 149–171, i–viii (including title-page, contents, list of illustrations, and index to volume), pls. xix–xxi.

716. Contributions to economic geology (short papers and preliminary reports), Part II, Mineral fuels; David White and M. R. Campbell, geologists in charge. 1921.
*(a) Geology of Alamosa Creek valley, Socorro County, N. Mex., with special reference to the occurrence of oil and gas, by D. E. Winchester, pp. 1–15, pls. i–v.
*(b) The Upton-Thornton oil field, Wyo., by E. T. Hancock, pp. 17–34, pl. vi.
*(c) The Mule Creek oil field, Wyo., by E. T. Hancock, pp. 35–53, pl. vii.
*(d) Natural-gas resources available to Dallas and other cities of central north Texas, by E. W. Shaw and P. L. Ports, pp. 55–89, pls. viii–ix.
(e) The Lance Creek oil and gas field, Niobrara County, Wyo., by E. T. Hancock, pp. 91–122, pls. x–xiii.

719. Preliminary report on petroleum in Alaska, by G. C. Martin. 1921. 83 pp., 11 pls.

*721. Geology and petroleum resources of northwestern Kern County, Calif., by W. A. English. 1921. 48 pp., 2 pls.

*726. Contributions to economic geology (short papers and preliminary reports), 1921, Part II, Mineral fuels; David White and M. R. Campbell, geologists in charge. 1922.
(b) Geology of the Cement oil field, Caddo County, Okla., by Frank Reeves, pp. 41–85, pls. vi–xii.
(c) Oil prospects in Washington County, Utah, by Harvey Bassler and J. B. Reeside, jr., pp. 87–107.
(e) Geologic structure of parts of New Mexico, by N. H. Darton, pp. 173–275, pls. xxx–l.
(f) Geologic structure and oil and gas prospects of a part of Jefferson County, Okla., by H. M. Robinson, pp. 277–302, pls. li–lii.
(g) The Lacasa area, Ranger district, north-central Texas, by C. S. Ross, pp. 303–314, pls. liii–liv.

*729. Oil shale of the Rocky Mountain region, by D. E. Winchester. 1923. 204 pp., 17 pls.

736. Contributions to economic geology (short papers and preliminary reports), 1922, Part II, Mineral fuels.
(a) The structure of the Madill-Denison area, Oklahoma and Texas, with notes on oil and gas development, by O. B. Hopkins, Sidney Powers, and H. M. Robinson, pp. 1–33, pls. i–vi.
*(b) Oil and gas prospects in and near the Crow Indian Reservation, Mont., by W. T. Thom, jr., pp. 35–53, pl. vii.
(c) Geology of the Wiles area, Ranger district, Tex., by C. E. Dobbin, pp. 55–69, pls. viii–ix.
(d) The Osage oil field, Weston County, Wyo., by A. J. Collier, pp. 71–110, pls. x–xiv.
*(e) Geology of the Ranger oil field, Tex., by Frank Reeves, pp. 111–170, pls. xv–xix.
*(f) Possibility of finding oil in laccolithic domes south of Little Rocky Mountains, Mont., by A. J. Collier and S. H. Cathcart, pp. 171–178.
(g) The Brooks, Steen, and Grand Saline salt domes, Smith and Van Zandt counties, Tex., by Sidney Powers and O. B. Hopkins, pp. 179–239, pls. xx–xxiii.
*(h) Stratigraphy of the El Dorado oil field, Arkansas, as determined by drill cuttings, by James Gilluly and K. C. Heald, pp. 241–254, pl. xxiv.

739. Mineral resources of Alaska, 1921, by A. H. Brooks and others. 1923.
(c) Recent investigations of petroleum in Alaska, by S. R. Capps, F. H. Moffit, A. H. Brooks, and G. C. Martin, pp. 77–147, pls. ii–iii.

751. Contributions to economic geology, 1923–24, Part II, Mineral fuels.
(a) Continuity of some oil-bearing sands of Colorado and Wyoming, by W. T. Lee, pp. 1–22, pls. i–vi.
(b) Progress report on a subsurface study of the Pershing oil and gas field, Osage County, Okla., by W. W. Rubey, pp. 23–70, pls. vii–ix.

WATER-SUPPLY PAPERS.

113. The disposal of oil-well wastes at Marion, Ind., by Isaiah Bowman. 1905. pp. 36–50.
*149. Preliminary list of deep borings in the United States (second edition, with additions), by N. H. Darton. 1905. 175 pp.
*240. Geology and water resources of the San Luis Valley, Colo., by C. E. Siebenthal. 1910. 128 pp., 13 pls.
*257. Well-drilling methods, by Isaiah Bowman. 1911. 139 pp., 4 pls.
*276. Geology and underground waters of northeastern Texas, by C. H. Gordon. 1911. 78 pp., 2 pls.
*317. Geology and underground waters of the Wichita region, north-central Texas, by C. H. Gordon. 1913. 88 pp., 2 pls.
*335. Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen. 1914. 365 pp., 9 pls.

GEOLOGIC FOLIOS.

NOTE.—Folios 148, 165, 172, 180, 189, 190, 202, 205, 206, 208, 212, 214, and 215 may be obtained from the Director of the Geological Survey at the prices indicated in parentheses.

*40. Wartburg, Tenn., by Arthur Keith. 1897.
*53. Standingstone, Tenn., by M. R. Campbell. 1899.
*64. Uvalde, Tex., by T. W. Vaughan. 1900.
*72. Charleston, W. Va., by M. R. Campbell. 1902.
*76. Austin, Tex., by R. T. Hill and T. W. Vaughan. 1902.
*82. Masontown-Uniontown, Pa., by M. R. Campbell. 1902.
*92. Gaines, Pa.-N. Y., by M. L. Fuller and W. C. Alden. 1903.
*94. Brownsville-Connellsville, Pa., by M. R. Campbell. 1903.
*102. Indiana, Pa., by G. B. Richardson. 1904.
*105. Patoka, Ind.-Ill., by M. L. Fuller and F. G. Clapp. 1904.
*107. Newcastle, Wyo.-S. Dak., by N. H. Darton. 1904.
*115. Kittanning, Pa., by Charles Butts and F. Leverett. 1904.
*121. Waynesburg, Pa., by R. W. Stone. 1905.
*123. Elders Ridge, Pa., by R. W. Stone. 1905.
*125. Rural Valley, Pa., by Charles Butts. 1905.
*132. Muscogee, Okla., by J. A. Taff. 1906.
*134. Beaver, Pa., by L. H. Woolsey. 1906.
*135. Nepesta, Colo., by C. A. Fisher. 1906.
*144. Amity, Pa., by F. G. Clapp. 1907.
*146. Rogersville, Pa., by F. G. Clapp. 1907.
148. Joplin district, Mo.-Kans., by W. S. T. Smith and C. E. Siebenthal. 1907. (50c.)
*159. Independence, Kans., by F. C. Schrader. 1908.
*163. Santa Cruz, Calif., by J. C. Branner, J. F. Newsom, and R. Arnold. 1909.
165. Aberdeen-Redfield, S. Dak., by J. E. Todd. (5c.)
172. Warren, Pa.-N. Y., by Charles Butts. 1910. (5c.)
*176. Sewickley, Pa., by M. J. Munn. 1911.
*177. Burgettstown-Carnegie, Pa., by E. W. Shaw and M. J. Munn. 1911.
*178. Foxburg-Clarion, Pa., by E. W. Shaw, E. F. Lines, and M. J. Munn. 1911.
180. Claysville, Pa., by M. J. Munn. 1911. (5c.)
*184. Kenova, Ky.-Ohio-W. Va., by W. C. Phalen. 1912.
189. Barnesboro-Patton, Pa., by M. R. Campbell, F. G. Clapp, and Charles Butts. 1913. (25c.)
190. Niagara, N. Y., by E. M. Kindle and F. B. Taylor. 1913. (50c.)
202. Eureka Springs-Harrison, Ark., by A. H. Purdue and H. D. Miser. 1916. (25c.)
205. Detroit, Mich., by W. H. Sherzer, 1917. (50c.)
206. Leavenworth-Smithville, Mo.-Kans., by Henry Hinds and F. C. Greene. 1917. (25c.)
208. Colchester-Macomb, Ill., by Henry Hinds. 1919. (25c.)
212. Syracuse-Lakin, Kans., by N. H. Darton. 1920. (25c.)
214. Raton-Brilliant-Koehler, N. Mex.-Colo., by W. T. Lee. 1922. (50c.)
215. Hot Springs, Ark., by A. H. Purdue and H. D. Miser. 1923. (25c.)

MIMEOGRAPHED PRESS NOTICES.

[Not incorporated in printed reports.]

1917. A. Oil possibilities in Pontotoc County, Okla.
B. Explorations for oil in southern Georgia.
1919. A. The unmined supply of petroleum in the United States.
B. Oil prospects near Seven Lakes, N. Mex.
1920. A. Oil prospects near San Diego, Calif.
B. Hints on oil prospecting.
C. Promising oil wells in south-central Arkansas.
D. Prospects for oil and gas near Poplar, Mont.
E. World view of the oil supply.
1921. A. Oil possibilities in southeastern Montana.
B. Oil fields of central Montana; Cat Creek anticline.
C. Can oil and gas be found in South Carolina?
D. Oil fields of central Montana; south-central Fergus County.
E. Possible oil in northeastern Montana.
F. Oil fields of central Montana; north-central Musselshell County.
G. Tests to detect the presence of small quantities of oil and bitumen.
H. Speculative possibility of finding oil in Coffee County, Ala.
I. The Ingomar dome, Mont.
J. Possibilities of oil in Grant County, Okla.
1922. A. Oil and gas prospects in the Cedar Creek anticline and vicinity, in Montana, North Dakota, and South Dakota.
B. Possible indications of oil in Mississippi.
C. Oil from the Nacatoch sand, El Dorado, Ark.
D. The oil supply of the United States.
E. Oil and gas prospects in Garfield County, Mont.
F. Geology of northern Fergus County, Mont.
G. Coal and oil resources of the Hanna Basin, Carbon County, Wyo.
H. Possible oil in southern Utah.
I. Wildcat wells in south-central Arkansas stop short of deep oil sands.
J. Recent drilling in the Soap Creek oil field, Crow Indian reservation, Mont.
K. Oil and gas may be found in the Eagle sandstone in the Lake Basin field, Mont.
L. El Dorado oil field in Arkansas not on an anticline.
M. A chance of more oil in southwestern Texas.
N. The Kevin-Sunburst oil field, Mont.
O. Old oil fields come back.
P. Possible new oil fields in the Bates Hole district, Wyo.
1923. A. Possible oil and gas in northwestern North Dakota.
B. Oil in Lee County, Va.
C. Possibility of finding oil in deep sands near the Osage field, Wyo.
D. Oil and gas prospects north of the Pryor Mountains, Mont.
E. Promising places for oil in Moffat County, Colo.

MINERAL RESOURCES.

Statistical reports entitled "Mineral Resources of the United States" have been published annually since 1882. These volumes are a consolidation of chapters on the several minerals which are issued separately in advance. A preliminary summary of the mineral resources of the United States has been published annually, within a few months after the end of the year covered by the statistics, since 1918. A monthly press bulletin, "Statistics of crude petroleum," has been published in mimeograph form since 1918.

MAPS.

In addition to the detailed maps in the reports listed above, the United States Geological Survey has published maps, on scales of 8 to 12 miles to the inch, showing the location of oil and gas fields, oil pipe lines, and refineries in the following States: California, Illinois, Kansas, Kentucky, Louisiana, Oklahoma, Pennsylvania, West Virginia, and Wyoming. Copies of these maps may be obtained on application to the Director, United States Geological Survey, for 50 cents each. Maps of Ohio and Texas are in preparation. A map of the oil and gas fields of the United States, on a scale of about 40 miles to the inch, published in 1922, may be obtained for $1.

PUBLICATIONS BY STATES.

In the subjoined list of Geological Survey publications on petroleum, natural gas, and oil shale, arranged by States, the following abbreviations are used: A,

Annual Report; P, Professional Paper; B, Bulletin; W, Water-Supply Paper; GF, Geologic Folio; PN, Press Notice.

Alabama:
Coffee County ..... PN, 1921 (H)
Fayette field ..... B 471-a
Hatchetigbee anticline ..... B 661-h
Alaska:
Alaska Peninsula ..... B 467
Bear River ..... B 225
Cape Yakataga ..... B 225
Cold Bay ..... B 225, 259, 739-c
Controller Bay ..... B 225, 259, 314, 335
Cook Inlet ..... B 225, 259, 739-c
General ..... B 250, 259, 662-a, 719, 739-c
Nenana coal field ..... B 739-c
Arizona:
Navajo country ..... P 93
Arkansas:
El Dorado ..... B 736-h, PN, 1922 (C, L)
Eureka Springs-Harrison ..... GF 202
Fort Smith-Poteau field ..... B 541-b
Hot Springs, Ark ..... GF 215
Southern ..... PN, 1920 (C), 1922 (I)
Southwestern part ..... B 691-j
California:
Barstow-Kramer region ..... B 541-e
Bitterwater Valley ..... B 581-d
Cantua-Panoche region ..... B 431-a
Coalinga district ..... B 213, 357, 398, 603
Contra Costa County ..... B 349-f
Cuyama Valley ..... B 621-m
Graciosa district ..... B 213
Kern County ..... B 721
Kern River field ..... B 213
Los Angeles district ..... B 213, 309
McKittrick-Sunset region ..... B 213, 406, 721
Miner ranch field ..... B 349-f
Parkfield area ..... B 691-h
Peachtree Valley ..... B 581-d
Petroleum withdrawals and restorations ..... B 623
Priest Valley ..... B 581-d
Puente Hills ..... B 213, 309
Salinas Valley area ..... B 691-h
Salt Lake field (Los Angeles district) ..... B 285-g, 309
San Diego County ..... PN, 1920 (A)
San Joaquin Valley 471-a, 603
Oil-field waters ..... B 653
Santa Clara district ..... B 213, 309
Santa Cruz quadrangle ..... GF 163
Santa Maria district ..... B 317, 322
Simi Valley ..... B 691-m
Summerland district ..... B 213, 321
Sunset-Midway field ..... P 116
Oil-field waters ..... P 117
Waltham Valley ..... B 581-d
Colorado:
Boulder district ..... B 213, 225, 265, 381-d
De Beque field ..... B 531-c
Florence field ..... B 260, 381-d
General oil-bearing sands ..... B 751-a
Great Plains ..... B 691-a
Moffat County ..... PN, 1923 (E)
Nepesta ..... GF 135
Northwestern ..... B 415
Oil shale ..... B 581-a, 641-f, 729
Petroleum withdrawals and restorations ..... B 623
Rangely district ..... B 350
San Luis Valley ..... W 240
Uinta Basin ..... B 581-a, 641-f
Georgia (southern) ..... PN, 1917(B)
Idaho:
Oil shale ..... B 711-b
Illinois:
Colchester-Macomb quadrangles ..... GF 208
Oil shale ..... B 641-l
Patoka quadrangle ..... GF 105
St. Louis quadrangle ..... B 438
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Marion district ..... W 113
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COAL.

By F. G. Tryon and Sydney A. Hale.

INTRODUCTION.

SPECIAL STATISTICAL REPORTS ON COAL IN 1922.

The year 1922 was the forty-first in the continuous statistical record of coal production maintained by the United States Geological Survey. In that year, as in others recently, the energies of the Survey staff engaged in the study of the economics of coal mining were largely diverted to answer calls for assistance from other Government agencies that dealt with coal. Special studies were made in 1922 and 1923 for the coal committee on the President's Conference on Unemployment, the Department of Commerce, the President's Fuel Distribution Committee of August, 1922, the Federal Fuel Distributor, the Interstate Commerce Commission, and the United States Coal Commission. The assistance given to these agencies lay not in framing policies but in answering questions of facts, and, as always, each answer was conditioned on the strict observance of the requirement that returns made by individual producers to the Geological Survey must be held confidential and that only totals for the locality or the State should be disclosed. Especially frequent were the requests for information from the United States Coal Commission, a body which had been specifically authorized by Congress to consult the records of existing Government departments, as follows:

> That every officer or employee of the United States whenever requested by the commission shall supply it with any data or information pertaining to any investigation by the commission which may be contained in the records of the office of such officer or employee.

The manner in which the Coal Commission availed itself of the general authorization in the act in requesting data from the Survey deserves to be recorded here. All requests for data from the Geological Survey originating in the Coal Commission were referred to the senior author of this report, who was acting at the time as statistical adviser of the commission, and were through him presented to the chief of the division of mineral resources of the Geological Survey. If the inquiries could be answered from the public or nonconfidential records of the Survey, access to those records was of course freely given. In this way the mailing lists of producers and consumers built up by the Survey were freely placed at the commission's disposal. If, on the other hand, the requests involved compilations from the confidential records of the Survey, the records were not turned over to the commission, nor were the detailed compilations permitted to

leave the custody of the Survey. All such tabulations of original records were conducted under the supervision of the responsible employees of the Survey, and all records, work sheets, and detailed tabulations involving the records of individual companies were retained by them. The only papers finally delivered to the Coal Commission for its use were those showing groupings and totals of companies prepared in such a way as to avoid divulging the individual returns.

Only a small part of the results of these special inquiries are recorded in this report; the rest will be found in the publications of the Coal Commission and other agencies for which the work was done or will be summarized in later publications of the Geological Survey.

The present report is therefore confined to the presentation of the annual statistics of production collected from the producers of anthracite and bituminous coal for the calendar year 1922, with certain historical data for earlier years. Many of the tables in this report have already been released in mimeographed form through the Survey's weekly coal report or the periodic reports on stocks of coal in the hands of consumers.

ACKNOWLEDGMENTS.

Without the generous cooperation of the coal producers, railroad officials, and consumers, whose responses to requests for information that were often burdensome have been most hearty and encouraging, these reports could not be prepared. Special thanks are due to the secretaries of local coal operators' associations and to officials of coal miners' unions, who have not only assisted in collecting facts but have contributed much essential information through their familiarity with local conditions. The State geologists of Alabama, Illinois, Iowa, Georgia, Maryland, Michigan, North Carolina, Oregon, Virginia, and Washington; the State mine inspectors of Alabama, Indiana, Kentucky, Tennessee, Texas, and North Dakota; the Pennsylvania State Department of Mines; the Department of Industrial Relations of Ohio; and the Industrial Commission of Utah have cooperated in the collection of reports.

Principal credit is due to Miss Lida Mann, of the United States Geological Survey, under whose painstaking supervision the annual statistics of bituminous coal were compiled, and to her assistant, Miss J. M. Corse. The annual statistics of anthracite were compiled by Mrs. H. L. Bennit, and the weekly and monthly information on production by Miss R. M. McKinney, under the supervision of W. F. McKenney. The canvass of wagon mines in 1922 was also supervised by W. F. McKenney. The tables of exports and imports were compiled by J. A. Dorsey from the records of the Bureau of Foreign and Domestic Commerce. F. G. Tryon was in charge of the work, and Sydney A. Hale wrote most of the text of this report.

REVIEW OF THE COAL INDUSTRY IN 1922.

SALIENT FEATURES.

The labor situation was the overshadowing feature in the history of the coal industry in the United States in 1922. Two general strikes, one in the anthracite region of Pennsylvania and the other in the unionized and in some of the nonunion bituminous-coal fields

of the country, gave it this unusual position of dominance. Moreover, the grip of the strikes was intensified by the fact that they began simultaneously. The strike in the bituminous fields involved a greater number of men than any previous one covered by the records of the Geological Survey. There have been bituminous strikes in recent years that exceeded the general strike of 1922 in the number of days lost per striker—notably the strike in southern Ohio in 1914 and the strike in the State of Washington in 1921—but neither in the total number of men affected nor in the tonnage and territory involved were they at all comparable with the strike of 1922. The strike in the anthracite region of Pennsylvania, which outlived that in the bituminous fields, was only one day shorter than the famous hard-coal strike of 1902, which was settled by presidential intervention.

The labor disturbances incident to a year of "normal" operation in the bituminous trade do not seriously affect the value or the accuracy of statistics of soft-coal production as an index of general industrial progress and retrogression. The productive capacity of the bituminous-coal mines of the United States so far exceeds the maximum demand on them, when the demand is properly distributed, that ordinary local or sectional interruptions to production are easily offset by speeding up operations in nonaffected areas. Nature has been so generous in her distribution of the bituminous-coal deposits of the country and man so eager to exploit them that such temporary readjustments can usually be effected with the minimum dislocation in the channels of trade.

It is obvious, however, that an interruption to mining activity that ties up 60 per cent of the normal productive capacity of the bituminous-coal mines of the country for approximately 20 consecutive weeks in one year must tend toward a reversal in the normal relation existing between industry and the production of bituminous coal by making industry subordinate to coal production instead of coal production subordinate to industry. Just how far this tendency went it is impossible to state. Before the extent of this reversal could be measured it would be necessary to know how much industrial activity was curtailed by the strike, how many plants were compelled to suspend because of lack of coal supplies, how many orders were delayed, and how many orders were postponed. Without these data, some of which are not available and some of which do not exist, definite conclusions as to the effect of the strike upon industry can not be reached.

Any attempt at approximating the effect by comparing the total production of bituminous coal in 1922 with that in the preceding year is complicated by the great industrial depression that began in the last half of 1920 and did not end until 1922. That depression exercised so profound an influence on coal production in 1921 that in 1922, despite the strike and despite the interference with nonunion production by reason of a strike of railroad shopmen, the total output of bituminous coal showed a slight increase over that made in the preceding year. Collateral evidence that this depression was still exerting an influence during the first six months of 1922 is to be found in the fact that the demand for coal after the strike started was not sufficient to test the full productive capacity of all the nonunion mining fields.

Although, for the reasons stated, it is impossible to measure definitely the effects of the bituminous-coal strike upon general industrial progress, subsequent developments support the conclusion that it tended to reverse the normal relation between the production of soft coal and commercial activity. Not only did the output of bituminous-coal rise sharply in the following year, but it established a remarkable record for steadiness, in response to a sustained demand unparalleled even in the war years. The volume of revenue-paying freight handled by the American railroads in 1923 broke all previous records. From these two facts it seems fair to assume that the bituminous-coal strike at least retarded the return of prosperity. Undoubtedly many projects were held up until the mining atmosphere had cleared, caution being encouraged while the strike was on. In other words, while the depression in part counteracted the effects of the strike, it did not wholly remove them. The most notable contribution of the depression in this direction was the manner in which it permitted the accumulation of coal stocks prior to the strike. This particular phase of the situation is touched upon elsewhere (p. 444).

No difficulty arises in measuring the effect of the anthracite strike. It is to be found in the distributing machinery set up by the State of Pennsylvania and the anthracite producers after operations were resumed, in the retail delivery restrictions laid down in New York and Massachusetts, in the "pure coal" laws enacted by certain New England States in protest against "fireproof" coal, in the demand of certain New York and Massachusetts interests that an embargo be placed on shipments to Canada, and in the investigation into anthracite distribution made by the Interstate Commerce Commission. In considering the effect of this strike, however, the essential difference between the predominating demand for anthracite and bituminous coal must be borne in mind. Over 80 per cent of the bituminous coal produced in the country is used industrially, including coal used in making coke and by the railroads. Between 65 and 75 per cent of the Pennsylvania anthracite shipped finds its way into the bins or cellars of individual householders or owners of apartments for domestic heating. The rate of consumption of this part of the anthracite output is determined by the weather and is independent of industrial conditions. Outside of eastern communities, where the popular interpretation of antismoke ordinances creates a feeling that the use of anthracite is compulsory, the territory in which the steam sizes of anthracite may be distributed in competition with bituminous coal is decidedly small. Normally, therefore, the fluctuations in the rate of production of these sizes reflect directly contemporaneous conditions in the bituminous-coal industry and indirectly the state of general business activity. With practically no developed reserve capacity to call upon, however, the strike created a shortage in all sizes of anthracite, and this permitted a relatively heavier production of steam sizes after the strike. But this increase in the percentage of small sizes, it should be noted, was a direct result of the strike, not of general industrial conditions. So here, too, the rule was reversed.

The course of the industry during the last 23 years is shown in Figure 16.

BITUMINOUS COAL TRADE IN 1922.

Strike early foreseen.—The general strike that was to be the major event in the history of the bituminous-coal trade in 1922 was foreshadowed months before it began. With the collapse of the post-armistice boom in 1920 two movements affecting the relations between the United Mine Workers of America and the operators in the organized fields had been launched and steadily pushed. One movement was based on the demand that basic rates of pay, pegged at the highest levels in the history of the industry, should be lowered in sympathy with the downward trend in many other industries.

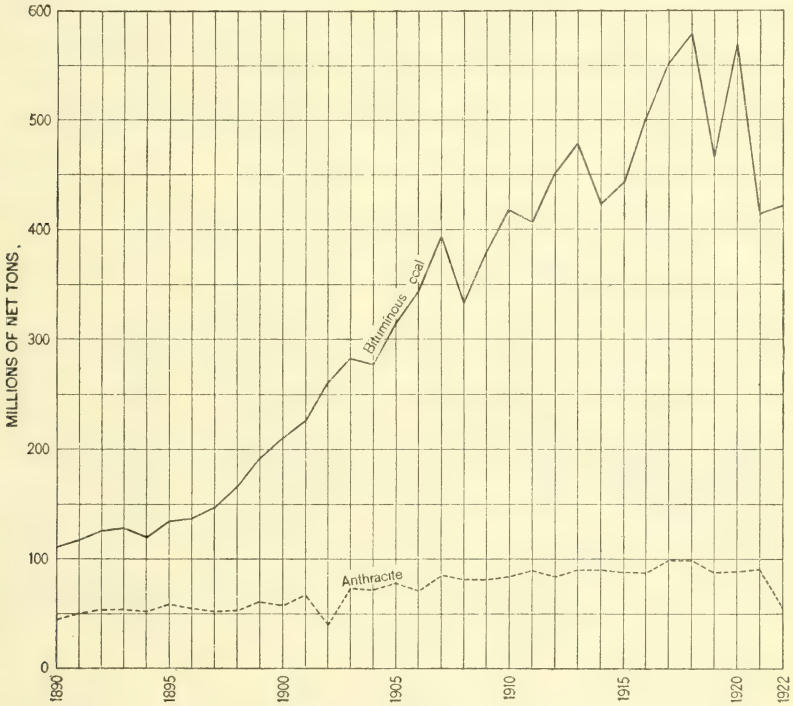


FIGURE 16.—Bituminous coal and anthracite produced in the United States, 1890–1922.

The other was based on the demand that wages in the districts not included within the central competitive field (which comprises Illinois, Indiana, Ohio, and western Pennsylvania) should be determined by the competitive conditions confronting these so-called outlying districts and not by the wage scales fixed for the central competitive field. This proposal for separate district agreements was persistently opposed by the union, which also declined to give any intimation that it would consent to a reduction in wages. As far back as October, 1921, the union, speaking through its international president, showed plainly that it had no intention of surrendering any of its power to exert economic pressure upon the country for the purpose of maintaining its position, when it declined to give the Federal Government any assurances that might be construed as limiting its freedom of action.

The danger of a strike came to the immediate foreground, however, in January, 1922, when operators in western Pennsylvania and southern Ohio refused to meet with the union representatives and operators from Illinois and Indiana in a joint interstate wage conference to discuss a new agreement. This refusal was given by the union as a reason for refusing to confer with the operators of Illinois and Indiana, who at that time expressed a willingness to meet with the union representatives despite the defection of operators in other sections of the central competitive field. The operators in southern Ohio and western Pennsylvania based their refusal to join an interstate conference on the ground that such a meeting would open the way for further indictments under the Sherman law such as had been voted by a Federal grand jury in Judge Anderson's court at Indianapolis two years before and the conviction that shifting currents of trade had made the central competitive field an outworn unit for basic wage making. It was further urged on behalf of these operators that the provision in the agreement of 1920 calling for such a conference was void because the strikes of that year, which forced the operators to agree to day rates above those fixed in the original contract,[1] had destroyed that agreement. These operators expressed a willingness to meet in district conference at any time.

In the main both groups held to their positions, the union refusing to take part in any conference that did not include all the districts represented in the central competitive field and operators from the "secessionist" districts refusing to take part in a conference that did include all those districts. Between the time that these opposing positions were first stated and the beginning of the strike, on April 1, several attempts were made to find a middle ground, but without success. During that period, too, there was some shifting in the attitude of the operators in other parts of the central competitive field, reports of discontent among the workers in western Pennsylvania and in West Virginia, and threats by the Illinois district organization of the United Mine Workers of America that it would make a separate contract with Illinois operators if the plan for an interstate conference failed. It is unnecessary to examine any of these developments in detail. What is worth emphasizing, however, is the fact that the break which led to the strike came not as the result of a joinder of the real issues of wage rates and autonomy of the outlying districts but from a dispute that to the public at large was one of technicalities.

INDUSTRY PREPARES FOR LABOR CONTEST.

These long drawn out pre-strike controversies were in marked contrast to the preliminaries to the general strike of November and December, 1919.[2] Although labor unrest had made its presence felt as early as August in that year, the danger of a strike did not become impressed upon the buying public until a few weeks before the suspension. From armistice day (November 11, 1918), when reserve stocks in the hands of industrial consumers and retail dealers approximated 63,000,000 net tons, until shortly before the strike in November, 1919, the quantity of coal held in storage had steadily dimin-

[1] U. S. Geol. Survey Mineral Resources, 1921, pt. 2, p. 506, 1923.
[2] Idem, pp. 504–505.

ished. Between January 1 and April 1, 1922, on the other hand, consumers added at least 15,000,000 tons to their storage piles, so that the total stocks on hand when the strike began probably exceeded the total held on November 1, 1918. (See fig. 17.)

The demand for coal for current consumption during the first quarter of the year was so low that this increase in storage was effected without approaching the weekly averages of production immediately before the general strike of 1919. During October, 1919, the weekly production averaged 12,281,000 tons. The highest weekly figure reached during the first three months of 1922 was 11,851,000 tons, in the week ended March 25. (See fig. 18.) The production for the first week in January was 7,700,000 tons; by the

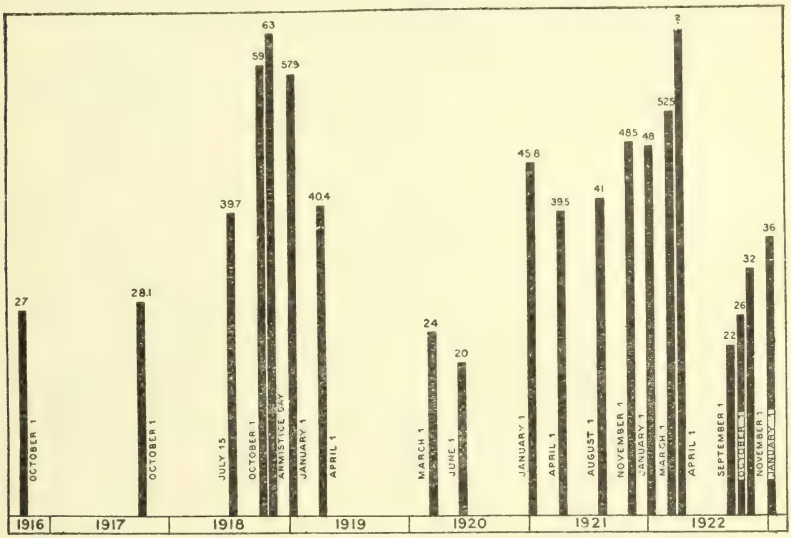


FIGURE 17.—Total commercial stocks of bituminous coal, October 1, 1916, to January 1, 1923. Figures represent millions of net tons and include coal in hands of railroads, industrial consumers, public utilities, and retailers. Coal for steamship fuel, on Lake docks, and in transit is not included.

end of that month it was almost 10,000,000 tons a week, and the 10,000,000-ton mark was passed the first week in February. For the 13 weeks to April 1 the weekly average was 10,295,000 tons.

It was not until the middle of February that the trade in general woke up to the fact that a stocking movement was under way. Prior to that time interest had centered in the domestic demand, which, of course, fluctuated with the weather. The fact that the demand for storage and for current consumption combined at no time during this period tested the productive capacity of the mines helps to explain why the storage buying attracted so little attention. It also explains why this entire accumulation was effected with little change in the prices on spot coal. The average increase between January 1 and April 1, according to the quotations published in the coal-trade journals at that time was less than 25 cents a ton, and for many coals the price continued to decline.

In addition to the accumulation of reserve supplies, many buyers whose regular source of supply is the union fields sought to fortify

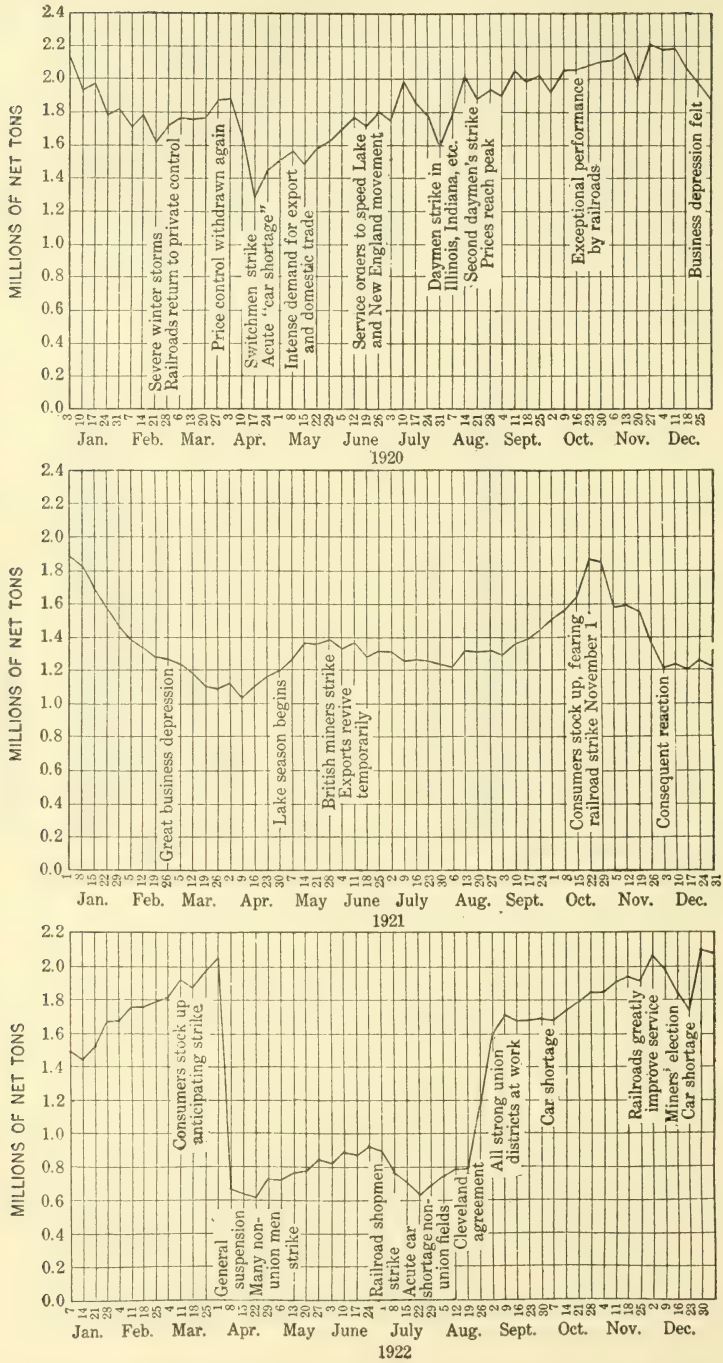

MILLIONS OF NET TONS
Severe winter storms
Railroads return to private control
Price control withdrawn again
Switchmen strike
Acute "car shortage"
Intense demand for export and domestic trade
Service orders to speed Lake and New England movement
Daymen strike in Illinois, Indiana, etc.
Second daymen's strike
Prices reach peak
Exceptional performance by railroads
Business depression felt
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1920
MILLIONS OF NET TONS
Great business depression
Lake season begins
British miners strike
Exports revive temporarily
Consumers stock up, fearing railroad strike November 1
Consequent reaction
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1921
MILLIONS OF NET TONS
Consumers stock up anticipating strike
General suspension
Many non-union men strike
Railroad shopmen strike
Acute car shortage non-union fields
Cleveland agreement
All strong union districts at work
Car shortage
Railroads greatly improve service
Miners' election
Car shortage
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
1922

FIGURE 18.—Average production of soft coal per working day for each week, 1920–1922.

themselves against a strike by entering into short-term contracts with nonunion producers. West Virginia, for example, normally ships no coal for general industrial purposes into the Chicago territory, but in the few weeks immediately preceding the strike contracts for a considerable tonnage were placed with shippers of nonunion West Virginia coal, who carried on active solicitation of steam business in that market. As a result, when the strike began approximately 70 per cent of the estimated nonunion production of the country was under contract.

EFFECTIVENESS OF THE STRIKE.

Prior to April 1 there had been many operators and many consumers who were of the opinion that the union could not hold out against the demand for a reduction in wages. This opinion had been encouraged by the rumors of dissensions within the union ranks and the factional fights waged against the international officers. When April 1 came, however, every organized field not working under an unexpired contract—and that included every important organized district except Kentucky and Tennessee—went out in response to the strike call. Moreover the union took the operators by surprise by making a successful invasion of the nonunion strongholds in the Connellsville, Westmoreland, and Somerset fields. Although it was unable to hold permanently the gains made in those regions, the union campaign seriously curtailed operations for several months.

In West Virginia the strike was less successful. The nonunion strongholds of Pocahontas, Tug River, Kenova-Thacker, and Logan remained at work, as had been expected. A few mines in the Winding Gulf district were closed during the first weeks of the strike, but thereafter the entire district was at work.

On the other hand, in the union districts in northern West Virginia the men very generally responded to the strike call, and though efforts were made by certain operators to resume on an open-shop basis, they were but partly successful. Between the union north and the nonunion south lay the debatable ground of the Kanawha Valley, and here the contest long remained in doubt. The New River field, at the upper end of the valley, had been organized during the war, but had broken away from the union in 1921 and early 1922. In this field somewhat over half the mines were closed in the early weeks of the strike, but men gradually drifted back to work, and before the end the field was shipping at its normal rate. Downstream in the Kanawha Valley proper, there was also a movement among some though not all of the operators to reopen the mines on an open-shop basis, but it did not gain headway enough to add much to the supply of coal during the strike. A detailed study of the degree to which the several fields were affected by the strike is shown elsewhere in this report (p. 518).

GOVERNMENT CONTROL OVER PRICES AND DISTRIBUTION.

Although production dropped from 10,768,000 tons in the last week of March to 3,970,000 tons the first week in April, there was no sharp reaction in prices as a whole until well into May. This led to Government control, first of prices and then of distribution.

There were three distinct phases of this regulation—(1) cooperative efforts at price control in the nonunion fields, initiated by the Secretary of Commerce; (2) regulation of distribution through the employment of the emergency powers of the Interstate Commerce Commission; (3) coordination of the price and distribution supervision, first through a presidential committee without statutory standing and later through the office of the Federal Fuel Distributor. This office, to which a legal basis was given by the Cummins-Winslow embargo law (Public No. 348, 67th Cong.), validated the action taken by the Interstate Commerce Commission to control distribution, as there was some question concerning the scope of the commission's authority.

The first phase began with a conference between the Secretary of Commerce and representatives of the producing fields then operating. This conference was called on May 18 to consider what steps might be taken to prevent a repetition of the runaway market of 1920. It was followed by a general conference of operators called by the secretary on May 31. At this conference each producing district was asked to name an advisory committee to consult with the secretary and advise him as to conditions. In order to avoid any question of combination, however, the secretary put the determination of maximum prices upon the basis of a transaction between himself and each individual operator. It was the understanding that the maximum prices named would be based upon the Fuel Administration figures, with such modifications as were warranted by changed conditions since the promulgation of the Garfield scales. The secretary began by fixing a base (mine-run) price of $3.50 f. o. b. mines on coal produced in the Virginias, Tennessee, and eastern Kentucky. Alabama operators said they would accept 25 cents less than the Garfield maxima. Western Kentucky operators asked $4.25, but to this the secretary refused to assent. The $3.50 base was later increased to $4.50. After the strike the Federal Fuel Distributor endeavored to agree with the operators on maxima in the union fields.

Notwithstanding the fact that all operators did not cooperate with the Secretary of Commerce, this price campaign exercised a marked restraining influence and checked the rapid advance of prices where, indeed, it did not reduce them. The 1st of July, however, brought a new factor into the situation when the railroad shopmen went on strike. This strike slowed up transportation, sending production down from 5,552,000 tons in the week ended June 24 to 3,822,000 tons in the third week of July. With no settlement of the strike in prospect, New England and the Northwest grew increasingly apprehensive that winter reserve stocks could not be built up, and "essential" industries in other parts of the country began to complain. This led to the second phase of control.

Something of the distribution problem confronting the Government and the coal industry can be pictured from the map illustrating the strike areas (Pl. V, p. 516). The mines in Ohio and western Pennsylvania, heavy shippers to the Lakes, were idle. The great Pittsburgh district was cut off from its nearest source of supply. So also was the Chicago district. The Atlantic seaboard was deprived of all its union-mined coal and was compelled to share the production from the nonunion mines of the Virginias and Pennsylvania with the Lakes

and western inland consumers. In addition, the fact that the anthracite mines were also closed placed an additional burden upon the bituminous mines that were running. In order to tighten Government control over distribution and prices, therefore, it was decided to create a presidential fuel committee and to invoke the active aid of the Interstate Commerce Commission. The commission had played an important part in the emergency control of 1920, and it was hoped that the commission's participation in the regulation would add something more than "a moral force" to the Government's efforts at extra-legal price control.

The presidential fuel committee was created in July. Its chairman was the Secretary of Commerce. The other members were the Secretary of the Interior, the Attorney General, a member of the Interstate Commerce Commission, and the Federal Fuel Distributor. Subordinate to this central organization were (*a*) an administrative committee, with the Federal Fuel Distributor as chairman, and coal men, railroad officers, and Government officials as associates, each member in charge of a separate phase of distribution; (*b*) district coal committees in each of the principal producing districts, to distribute orders placed by the Federal Fuel Distributor; and (*c*) governors' fuel committees, to report on local conditions and to prevent intrastate hoarding and profiteering. The organization plans provided that Federal Government orders should pass through a coordination committee to the Federal Fuel Distributor, Lake shipments should move through the Ore and Coal Exchange, and railroad-fuel orders should be handled by a special committee. Except as ordered by the Interstate Commerce Commission or the Federal Fuel Distributor, operators were to continue to function individually in handling ordinary business.

Control of distribution through the issuance of special service orders by the Interstate Commerce Commission began on July 25, when the railroads were authorized to disregard shippers' instructions as to routing when such action would expedite transportation. On the same day the commission set up preferences and priorities in transportation and ordered embargoes placed against consignees who should fail to unload coal within 24 hours after placement. These orders were modified, changed, and vacated as the situation became more normal.

Although nobody challenged the authority of the Federal Fuel Distributor in court action, up to September 22, there was no legal provision for his office. The Cummins-Winslow law, which went into effect on that date, declared the existence of a national emergency, created the office of a Federal Fuel Distributor, and specifically enlarged the powers of the Interstate Commerce Commission to include the issuance of embargoes and to take such other steps as might be necessary to insure equitable distribution and "to prevent * * * the purchase or sale of coal * * * at prices unjustly or unreasonably high." Another by-product of the strike was the enactment of the law creating the United States Coal Commission to make a comprehensive survey and report to Congress on the state of the coal industry.

HOW THE STRIKE WAS SETTLED.

In July the President of the United States attempted to bring the union and the operators together, but he was no more successful than others who had tried to accomplish the same thing. He proposed that the miners return to work at the old (1920) wage scale, pending the determination of future rates by a presidential commission. The majority of the operators were willing to accept this proposal, but the union rejected it. President Harding then called upon the operators to return to their headquarters and make an effort to reopen their mines. For this effort he pledged the full protection of the State and Federal Governments. Outside of western Pennsylvania, however, the disposition of the operators was to mark time.

When the outlook appeared darkest, the union abandoned its position that the strike could not be settled without a revival of the central competitive field agreement. A conference to which all union operators were invited was called to meet at Cleveland, Ohio. Operators' associations in Ohio and western Pennsylvania refused to be parties to this conference. Operating organizations in Illinois, Indiana, and central Pennsylvania took a similar stand, but individual producers were left free to take such action as they saw fit. Finally, on August 17, after several operators had withdrawn from the Cleveland meeting, an agreement to end the strike was reached. This agreement provided for the immediate return to work of all miners at all mines whose operators signed the agreement, continuation of the existing rates of pay and working conditions until March 31, 1923, and the creation of a special committee of inquiry into the coal industry. This last-named proposal was dropped when the United States Coal Commission was appointed. Although the terms of settlement were displeasing to many operators, the more important union bituminous-coal districts quickly fell into line with the provisions of the Cleveland agreement, and by the week ended September 2 production had risen to 9,688,000 tons.

PERIOD OF READJUSTMENT.

The last five months of the year was a period of readjustment. Prices for spot coals, which had reached an average in excess of $6 a ton in the later part of July, showed a steady downward trend with the resumption of large-scale production, and the weekly output rose more or less steadily, passing the 11,000,000-ton mark in October. Spot-price levels, even after the strike, were considerably above those prevailing during the corresponding months in 1921. But the advantages accruing to the operators by reason of these high prices were partly offset by two facts. In the union fields the higher returns had to be balanced against nearly five months of inactivity. In the nonunion fields, after the strike was over, nonunion producers were frequently shut out from the higher-price markets by difficulties of transportation. The collapse of the fight to reduce wage rates in the union fields brought about advances in the wages paid in the nonunion districts. During the period in which the nonunion operators had the markets of the country to themselves the greater part of their product was moving under contracts made prior to

April 1 at prices substantially lower than the later spot-market quotations. The Hoover maxima applied only to spot transactions, whereas the last Garfield scale covered both contract and spot tonnage.

One of the first problems that engaged the attention of the industry after the strike was that of speeding up shipments to the Lakes. Some attempts in that direction had been made during the strike by the Federal Fuel Distributor, but with a weekly output of less than 5,000,000 tons he could do little. On August 21, when mining was resumed on a large scale in the union fields, the total cargo dumpings were 10,287,569 tons less than the total for the corresponding period in 1921. By the end of the year the total was 18,522,000 tons, as compared with 22,413,000 tons in 1921. Of the total for 1922, however, 1,154,000 tons was shipped to Lake Erie destinations that ordinarily take all-rail deliveries; in 1921 the total quantity moved to Lake Erie destinations was only 244,204 tons.

The last five months of the year witnessed an unusual demand in the East for bituminous coal for domestic heating, owing to the shortage created by the anthracite strike. That same demand was also felt in both branches of the coke trade, and bituminous coal, as the raw material for coke, shared in these gains.

The export trade, discussed in detail on page 566, was adversely affected both by the strike in this country and by the recuperative powers shown by the coal industry in the United Kingdom. The total exports from the United States (including shipments to Canada) were the smallest in over a decade. Imports, on the other hand, showed an abnormal increase, because many industrial consumers along the Atlantic seaboard, including public utilities, bought British coal in the summer to offset deficiencies in receipts of coal mined in this country, and a number of retail merchants in the same territory renewed their acquaintance with Welsh anthracite after a lapse of 20 years.

ANTHRACITE TRADE IN 1922.

The history of the anthracite industry of Pennsylvania in 1922 revolves around the general suspension in production that began on April 1 and did not end until September 11, when the striking miners returned to work. In common with the strike in the organized bituminous-coal fields of the country, the stoppage of major operations took place without a real joinder of issues between the employers and their employees. Unlike the situation in the bituminous fields, however, the suspension came without prolonged preliminary warning to the consumer. Moreover, for several years the production of the domestic sizes of anthracite—and, what is more important, the capacity for producing it—has been nicely adjusted to the annual demand, so that, even if the strike had been anticipated much sooner than it was, it would have been impossible to accumulate a reserve storage pile comparable to that accumulated in bituminous coal. Doubtless a greater accumulation than that actually made would have been possible, but a suspension that lasted 23 weeks was bound to result in an irreparable shortage.

REVIEW OF STRIKE.

In the anthracite region, as in the organized bituminous-coal fields the year opened with labor employed under the terms of an agreement made in 1920 and expiring on March 31, 1922. Representatives of the miners met in a tridistrict convention at Shamokin, Pa., in January and formulated a program embodying 19 demands for presentation to the operators. These demands, which were to form the basis of negotiations for a new wage contract, included increases in contract and day rates, "punitive" compensation for overtime, a universal eight-hour day, full recognition of the union, and the "check-off." The particular feature that led to the strike, however, was the addition of a recommendation favoring a suspension if the new agreement were not concluded by April 1. This recommendation was contrary to the practice that had prevailed in anthracite negotiations for several years—to continue work after the date of expiration of the old agreement with the understanding that any changes decided upon would be retroactive to that date. At the joint conferences with the operators, which began on March 15, the union representatives insisted upon following this unusual recommendation, and the order for a general suspension on April 1 was issued on March 20.

Outside of an insignificant output of reclaimed coal dredged from the rivers, the tie-up of operations was complete. Negotiations on the new contract, however, continued until June 14, when they were broken off. During these negotiations the union had rejected a counter proposal of the operators for a reduction that would have averaged 21 per cent under the 1920 scale, also proposals to submit the dispute to arbitration. The Senators from Pennsylvania, acting upon behalf of the President, brought about a resumption of negotiations late in August. At a meeting held in the office of Senator Pepper in Philadelphia on September 3, an agreement was reached for a resumption of operations on the following terms: That the scale and working conditions adopted in 1920 should be extended until August 31, 1923; that operators and the union unite in recommending to Congress the enactment of legislation creating a separate commission to investigate the anthracite industry; and that production be continued after August 31, 1923, upon such terms as the parties might agree upon in the light of a report by such a commission. Work was resumed a week later. The separate commission, however, was never authorized; instead a provision was inserted in the Borah bill directing the United States Coal Commission to make a separate report on anthracite not later than July 1, 1923.

TRADE CONDITIONS PRECEDING THE STRIKE.

That the consuming public was not stimulated to buy heavily by the demands of the miners is shown by the shipments of anthracite during January and February. In January the total was only 4,848,053 gross tons, the smallest shipments for that month since 1915. February showed a modest increase, but the total for the month was less than that of February, 1921, although greater than

the February shipments in either 1919 or 1920. In March, however, the shipments rose to 6,778,667 gross tons—the largest total for that month since 1918, when the record of 7,276,777 gross tons was made. Compared with the shipments in February this was an increase of 1,020,943 gross tons, or 26.7 per cent, in the domestic sizes and 518,710 gross tons, or 36.8 per cent, in the steam sizes. Although the end of March saw most of the domestic coal that had been placed in mine storage earlier in the year on its way to the yards of the retail coal dealers, there were still heavy stocks of steam sizes that did not move out until the strike was on.

As a matter of fact, until the last two weeks in March the trade, both steam and domestic, was concerned more with the day-to-day fluctuations of the end of the coal year than with the threatened strike. There were, of course, some far-sighted retail coal merchants who bought liberally in anticipation of the strike and others whose relations with certain producing companies were so close that they were ready to accept surplus tonnage. On the other hand, many householders, who had enough coal in their cellars to carry them through the spring and did not expect to need more before the fall, could not be induced to take an interest in the danger of a suspension in production on April 1.

How little effect the strike menace had upon buying during the early months of the year is illustrated by the f. o. b. mine quotations on "independent" coal. In discussing the commercial aspects of the anthracite industry it is customary to divide the producing companies into two groups. The first group, comprising the "railroad" or "old line" companies, is small in number but produces by far the greater percentage of the anthracite mined. It has been the policy of members of this group in recent years to announce their schedules of prices at the beginning of the coal year and to adhere to them throughout the year. An occasional change may be made in these "company circulars," but for the most part they are maintained without regard to intraseasonal variations in demand for coal. The other group of producers is commonly known as "independents" or "individual shippers." Though some of the larger producers in this group strive for the same stability of price that exists in the "railroad" group, many others frankly follow the market, reducing and advancing their quotations as demand falls and rises. Independent quotations therefore furnish a sensitive barometer of fluctuations in demand. (For a further discussion of "company" and "independent" prices see p. 642.) In the following tables are shown maximum and minimum prices on independent coal by weeks for the first three months of 1922. For purposes of comparison the circular prices in effect during this period are given in the top line of the table.

Prices of anthracite per gross ton, f. o. b. mines, January 1 to April 1, 1922.

[From Coal Trade Journal.]

	Egg.	Stove.	Chestnut.	Pea.	Buckwheat.	Rice.	Barley.
Company	$7.60–$7.90	$7.90–$8.10	$7.90–$8.10	$6.00–$6.50	$3.50	$2.50	$1.50
Independent week ending:							
Jan. 7	6.50–7.50	7.85–8.10	7.85–8.10	4.25–5.00	2.50–3.00	1.50–2.00	1.00–1.50
Jan. 14	7.00–7.75	7.85–8.35	7.85–8.35	4.25–5.00	2.50–3.25	1.75–2.25	1.50–1.60
Jan. 21	7.00–7.75	7.65–7.95	7.75–7.95	4.25–5.00	2.50–3.25	2.00–2.25	1.50
Jan. 28	7.25–7.95	7.90–8.10	7.90–8.25	4.50–5.50	2.50–3.25	2.00–2.50	1.50–1.75
Feb. 4	7.60–7.75	7.90–8.10	7.90–8.15	5.25–5.75	2.75–3.50	2.00–2.50	1.50–1.75
Feb. 11	7.50–7.75	8.00–8.50	8.10–8.50	5.00–5.75	3.25–3.75	2.40–2.75	1.75–2.00
Feb. 18	7.25–7.75	8.00–8.25	8.00–8.25	4.75–5.25	3.15–3.75	2.00–2.75	1.75–2.00
Feb. 25	7.25–7.80	7.75–8.10	8.00–8.25	4.25–4.50	3.25–3.75	2.00–2.75	1.40–1.80
Mar. 4	7.00–7.90	7.50–8.25	7.90–8.25	5.10–6.10	3.25–3.50	2.00–2.50	1.75–2.00
Mar. 11	7.00–7.90	7.50–8.25	7.90–8.25	5.25–6.00	3.00–3.25	2.25–2.50	1.50–2.00
Mar. 18	7.25–7.90	7.50–8.25	7.90–8.25	5.25–6.00	3.00–3.25	2.25–2.50	1.50–2.00
Mar. 25	7.50–7.90	7.90–8.25	7.90–8.25	5.25–6.00	3.00–3.50	2.10–2.50	1.75–2.00
Apr. 1	7.50–8.25	7.90–8.50	7.90–8.50	5.25–6.00	3.00–3.50	2.10–2.50	1.75–2.00

POST-STRIKE TRADE DEVELOPMENTS.

Production during the strike period was practically limited to minor dredge operations. (See p. 452.) When the suspension was lifted, therefore, the real problem was not one of marketing but of allocation of the inadequate supply available. This was particularly true of the domestic sizes, which constitute the bulk of the anthracite output. The program adopted was both simple and effective. A few weeks before the strike ended the governor of Pennsylvania had appointed a nonstatutory body known as the Pennsylvania Fuel Commission. This commission went into conference with the anthracite distributors and producers and representatives of the Federal Government, and as a result the following program of distribution for domestic sizes was mapped out:

Distribution was to proceed in the normal way through the regular channels. The apportionment to different States of the coal shipped was to be based on shipments made to those States in the coal year ended March 31, 1922. In other words, each State and the Dominion of Canada was to receive the same percentage of the current production that it had received of the production of 1921–22. It was roughly estimated that the strike had cost the industry 40 per cent of the normal production for the coal year—that is, that the production for the coal year would be 60 per cent of the normal.

It was agreed by the industry, with the approval of the authorities of the State of Pennsylvania and the Federal Government, that distribution to the anthracite-consuming States and to each community therein would be made on that basis—that is, each community and each State should get currently 60 per cent of their normal requirements as fast as the rate of production would permit.

How well this plan worked out is indicated by the following table, which covers about 90 per cent of the domestic tonnage and shows that 38,118,952 gross tons of domestic sizes was shipped to the several States in the coal year ending March 31, 1922, by the companies reporting to the director of distribution named by the Pennsylvania Fuel Commission to have direct charge of the distribution work. On the 60 per cent allotment basis these same companies were called upon to ship 22,871,374 gross tons during the coal year ending March 31, 1923. Their actual shipments, however, exceeded this quantity by 2,099,556 gross tons.

[3] Federal Fuel Distributor Final Rept., p. 8, 1923.

Distribution of domestic anthracite, years ending March 31, 1922 and 1923, by States, in gross tons.[a]

State.	1922	1923		
		Allotment.	Shipments.	
			Total.	Increase or decrease from allotment.
Alabama	2,353	1,412	193	−1,219
Arkansas	522	313	28	−285
California	66	40		−40
Colorado	44	26		−26
Connecticut	1,637,525	982,515	1,027,052	+44,537
Delaware	211,641	126,985	149,967	+22,982
District of Columbia	530,670	318,402	318,397	−5
Florida	5,383	3,230	1,720	−1,510
Georgia	12,285	7,371	4,536	−2,835
Idaho	2	1		−1
Illinois	1,780,412	1,068,247	1,254,918	+186,671
Indiana	248,213	148,928	89,042	−59,886
Iowa	169,746	101,848	87,622	−14,226
Kansas	7,257	4,354	1,779	−2,574
Kentucky	2,996	1,798	1,189	−609
Louisiana	9,243	5,546	1,182	−4,364
Maine	443,582	266,149	280,423	+14,274
Maryland	867,344	520,406	576,458	+56,052
Massachusetts	3,491,070	2,094,642	2,270,512	+175,870
Michigan	1,002,665	601,599	446,516	−155,083
Minnesota	758,361	455,017	518,859	+63,842
Mississippi	316	190	31	−159
Missouri	87,134	52,280	57,306	+5,026
Montana	1,274	764	602	−162
Nebraska	52,396	31,438	18,597	−12,841
New Hampshire	180,954	108,572	121,172	+12,600
New Jersey	4,689,480	2,813,688	3,467,760	+654,072
New York	11,848,903	7,109,342	7,970,042	+860,700
North Carolina	17,189	10,313	6,347	−3,966
North Dakota	96,326	57,796	29,743	−28,053
Ohio	352,972	211,783	174,630	−37,153
Oklahoma	201	121		−121
Oregon	98	59	149	+90
Pennsylvania	7,267,357	4,360,414	4,950,984	+590,570
Rhode Island	587,877	352,726	329,206	−23,520
South Carolina	15,583	9,350	7,034	−2,316
South Dakota	96,776	58,066	56,174	−1,892
Tennessee	2,568	1,541	1,232	−309
Texas	10,121	6,073	3,033	−3,040
Vermont	88,463	53,078	54,701	+1,623
Virginia	203,531	122,119	102,783	−19,331
Washington	256	154	29	−125
West Virginia	10,750	6,450	5,989	−461
Wisconsin	1,326,979	796,187	582,974	−213,213
Wyoming	68	41	19	−22
	38,118,952	22,871,374	24,970,930	+2,099,556

[a] Does not include Hudson, Buck Ridge, and Delano coal companies.

The program adopted aimed at a normal distribution of the coal available, but it could not make up the deficiency caused by the strike. Household consumers were compelled to use other fuels, such as the smaller sizes of anthracite, bituminous coal, and coke, to tide them over. Severe weather toward the end of the calendar year further complicated the situation, particularly in New England and northern New York, and led to a demand for an embargo on shipments of anthracite to Canada. At the time the allotment program was adopted, however, the Pennsylvania Commission had assured the Dominion that it would be treated the same as the States. That promise was kept, although Canada did not receive a full 60 per cent.

PRICES.

In addition to the control exercised over the distribution of the domestic sizes, the Pennsylvania Fuel Commission, with the consent and approval of the Federal authorities, also sought to keep mine prices at reasonable levels. Its work in that connection is discussed elsewhere in this report.

STATISTICS OF PRODUCTION.

UNITS OF MEASUREMENT.

The standard unit of measurement adopted for this report is the net or short ton of 2,000 pounds, but as Pennsylvania anthracite is mined and sold by the gross or long ton of 2,240 pounds, that unit is used in the part of the report dealing with anthracite. Unless the unit is otherwise expressly stated, the word "ton" as here used means the net ton of 2,000 pounds, to which all other figures, however reported, have been reduced.

There is a steadily growing sentiment in favor of the general use of the net ton of 2,000 pounds as the standard unit of the coal trade, particularly for bituminous coal in the Eastern States, where both gross and net tons are now used. The use of both units is, of course, undesirable, but as many State and municipal laws require the use of the gross ton, and as freight rates throughout a part of the Eastern States are now fixed accordingly, it is difficult to make an immediate change to a standard unit. In reports on foreign trade and shipping rates quantities are expressed in either gross or metric tons, and here, too, the use of more than one unit is undesirable. The general use of the net ton in the United States, even in the anthracite region, is here recommended.

METHOD OF COLLECTING THE STATISTICS.

The statistics here published are obtained from the producers' written reports, most of them signed by officers of the companies that furnish the figures. These reports are collected by correspondence, which is supplemented by visits of field agents if correspondence has failed. The Geological Survey has no power to to subpoena records or to compel the filing of reports or to punish producers for rendering false reports.

Under this system accurate results can be obtained only by the generous cooperation of the producers in furnishing returns voluntarily. The operators generally make cordial responses to the Survey's questionnaires, with which they have become familiar through more than 40 years of contact and cooperation, so that a very large percentage of the returns are obtained by mail, leaving relatively few to be obtained by personal visits.

Accurate statistics might not be obtained under a system of voluntary reporting if information was requested which the operators were reluctant to furnish or concerning which they had a motive to misrepresent the facts. No questions of this character are asked by the Survey on its annual report forms, except possibly the questions concerning the value of the product and the occurrence of strikes. In 1920 and again in 1922, when the spot price of coal reached very high

levels, a number of operators declined to state the value of the coal they sold. The number and the importance of these failures to make returns and the method used by the Survey in estimating the values not reported are explained on page 548. The possible errors in the returns dealing with strikes are discussed on page 517.

The other questions asked by the Geological Survey in its annual schedule deal with the physical operation of the mines. They include such items as quantity produced, disposition of the product, number of men employed, time worked, methods of mining, and railroads over which shipments are made. The operators can obtain no advantage by concealing or misstating these facts, for the facts could be definitely ascertained from other sources. The operators' returns are constantly being checked by the departments of mines in States that commonly publish them, and they can be checked against the records of coal shipped by the railroads, which must agree in the aggregate with the reports made by the operators of coal tendered for shipment. These checks are sufficient to warrant public confidence in the substantial accuracy of the returns, subject to the limitations stated in presenting this report. Whether the voluntary system of reporting may be safely used as to inquiries concerning costs, prices, profits, and other financial matters is a different question. The Geological Survey has found it difficult, for example, to reconcile the statements of car supply voluntarily furnished by the railroads with the statements of time shut down for lack of cars voluntarily furnished by the mines, and it is aware that the current reports on time worked and lost by the mines published in its weekly coal statement contain very serious errors.

COMPLETENESS OF THE RETURNS.

A complete count of the thousands of wagon mines and country coal banks from which bituminous coal is dug in this country could be made only by sending agents up every creek and along every hillside in the coal-bearing regions. The cost of such a count would prohibit it, and in practice a limit must be set to the size of the mines to be considered. The Federal Census Bureau sets this limit at mines, producing approximately 1,000 tons a year. Many of the States that publish statistics set the limit higher. The Pennsylvania Department of Mines, for example, covers only enterprises employing as many as 10 men.

The Geological Survey desires to ascertain the total output of coal from all sources, large or small, in order to find the rate at which the country's sources of coal are being drawn upon. In practice, however, it has been found advisable to employ different methods for the commercial mines, on the one hand, and the country banks and wagon mines, on the other.

For the commercial mines statistics can be obtained largely by correspondence. Satisfactory lists have been built up which now contain the names of many thousand operators, past and present. The canvass of 1922 showed a total of 9,299 commercial mines in operation that year. To the mailing list new names are constantly being added from the trade journals, from reports of field agents, and from reports by the producers themselves. At intervals the list is checked against lists kept by associations of operators or State

officials and against lists of shippers kept by railroad-car distributors. Every tenth year the list is further supplemented by the enumerators of the Federal Census Bureau, who canvass the entire country. In 1922 many hundreds of new names were obtained from the field agents of the Federal Fuel Distributor and from the United States Coal Commission. Even after all this checking the list is not absolutely complete, but it is very nearly so.

Schedules of inquiry are mailed by the Geological Survey to all producing companies listed, and no company is dropped from the list until it has been definitely accounted for. To follow up companies from which no reply is received by correspondence, cooperative arrangements have been made with State geologists and coal-mine inspectors, secretaries of operators' associations, and other local agents, who make inquiry in person and report to Washington. In the Rocky Mountain States the work of following up the returns is now done by the branch offices maintained by the Geological Survey at Denver, Salt Lake City and San Francisco. Areas to which no permanent local representative of the Survey has been assigned can be covered only by sending out a field agent from Washington, and the present plans include regular work by such an agent every year.

Many of the smaller mines are operated so intermittently that the owners can not be found at the end of the year, and recourse must be had to railroads to find the number of tons of coal shipped by these mines, from which estimates of the number of men employed and the value of the product can be made. Such estimates are made in order to round out totals, but only when the evidence shows that a mine was in operation during the year and when all other means of getting the exact figures have failed. Wherever in this report the inclusion of estimates introduces the probability of significant error, that fact is indicated.

The method just described is used in the canvass of commercial producers, including mines that make an output of at least 1,000 tons a year and that are operated rather steadily year after year. To handle the numerous sporadic wagon mines is a different problem and requires a different method. For several years the Geological Survey attempted to canvass these "small mines" also by mail, but the results were found not to be satisfactory. The Survey in 1920 therefore turned to the railroads and asked for lists of all wagon mines that had shipped coal during the year, the date that each opened and closed, and the number of carloads shipped by each. The response of the railroads was instant and generous. Most of them were able to furnish the information required, which showed that a total of 4,405 wagon mines had shipped 4,513,800 tons of bituminous coal in 1920. The experiment showed that the only means of obtaining an adequate picture of the activities of wagon mines in a year of high prices is the records of the railroads.

In 1921, however, it was not considered worth while to ask the railroads for this information, because the profound depression in the coal market put the wagon mines temporarily out of business. For this reason, the statistics of production in 1921 do not include the output of wagon mines. The omission does not prevent a just comparison of the statistics for 1921 with those of other years, for if the figures for small mines were available, they would hardly raise the published total by 0.3 per cent.

The market conditions of 1922, on the contrary, induced great activity by the wagon mines. The high prices created by the strike, which reached at one time over $6 a ton, and the tendency of union miners in some of the mountainous districts to seek employment elsewhere while the commercial union mines were closed by the strike, combined to stimulate great activity by the wagon mines. The Geological Survey, therefore, again turned to the railroads and obtained the names of all wagon mines that shipped coal over their lines in 1922 and the quantity shipped. The total number of mines thus reported by the railroads, eliminating names already on the Survey's list of commercial producers was 4,851, and their total shipments during 1922 were 3,459,442 tons.

No attempt was made in 1922 to measure the product of country coal banks that did not ship by rail. Although the number of such banks runs into the thousands, their combined output is so small as to be negligible. Their product is sold locally, it does not involve the use of railroad cars, and it does not enter into competition with the output of commercial mines. When formerly the Geological Survey attempted to cover these producers regularly, the maximum tonnage ever reported for them was less than 1,000,000 tons a year.

No reports as to number of employees or time worked have ever been obtained from the wagon mines, and all the statistics of number of men employed, average days worked, and the like in this report are calculated from the returns from the commercial mines alone.

SUMMARY.

During 1922 the coal mines of the United States produced 422,268,099 net tons of bituminous coal and lignite and 54,683,022 net tons of Pennsylvania anthracite. The combined total, 476,951,121 net tons, was the lowest recorded since 1909, primarily on account of the strike losses in the output of anthracite. Compared with that of the preceding year the production of bituminous coal increased 6,346,149 tons, or 1.5 per cent. The anthracite output in 1922 was the smallest since the great strike of 1902, when the production for the year was cut to 41,373,595 tons, and was 35,790,429 net tons, or 39.6 per cent, less than the output in 1921.

The output of bituminous coal for the year closely approximated that of 1914—422,703,970 tons. The fact that the production was 1.5 per cent greater than in 1921 notwithstanding the prolonged strike in the organized districts throws an interesting sidelight on the depth of the commercial depression that swept over the country in the latter part of 1920 and continued throughout 1921.

The value of the bituminous coal and lignite produced in 1922 was $1,274,820,000, as compared with $1,199,983,600 in 1921—an increase of $74,836,400, or 6.2 per cent. The percentage increase in value, therefore, was more than four times as great as the percentage increase in quantity. The average increase in value was 13 cents a ton. The value of the anthracite produced dropped from $452,305,000 in 1921 to $273,700,000 in 1922—a decline of $178,605,000, or 39.5 per cent. The percentage decline in the value of the anthracite, however, was only 0.1 per cent less than the percentage decline in quantity.

Summary of statistics of coal produced in the United States, 1921 and 1922.

Production.

	1921		1922	
	Net tons.	Value.	Net tons.	Value.
Bituminous coal and lignite	415,921,950	$1,199,983,600	422,268,099	$1,274,820,000
Pennsylvania anthracite	90,473,451	452,305,000	54,683,022	273,700,000
	506,395,401	1,652,288,600	476,951,121	1,548,520,000

Increase or decrease, 1922.

	Quantity.		Value.	
	Net tons.	Per cent.	Dollars.	Per cent.
Bituminous coal and lignite	+6,346,149	+1.5	+74,836,400	+6.2
Pennsylvania anthracite	−35,790,429	−39.6	−178,605,000	−39.5
	−29,444,280	−5.8	−103,768,600	−6.3

Four new records for maximum production were made in 1922. The Territory of Alaska exceeded its total for the preceding year by 2,458 tons. Kentucky produced 42,134,175 tons, exceeding the 1920 record for the State by 6,443,413 tons, or 18 per cent. The expansion of mining activities in Kentucky, which produced less than 6,000,000 tons in 1901, has been one of the most remarkable events in the history of the bituminous-coal trade. Although the western part of the mining field is unionized, it was involved only slightly in the general strike of 1922, and the partly organized sections of the eastern part of the State also suffered little diminution in production through labor difficulties. The State therefore shared fully in the increased demand that came to the producing districts of the country which were not strike bound during the spring and summer of 1922. Compared with the output of 1921, production in the eastern district increased 4,959,585 tons and in the western district 5,118,267 tons. The large increase in output from mines in the western part of the State reflects not only the general situation outlined above, but the geographic advantage in the location of the coal fields of western Kentucky with respect to the Chicago industrial district. Chicago and Pittsburgh are the largest coal-consuming centers in the United States. The bulk of the coal used for general industrial purposes in the Chicago district comes from the mines of Illinois and Indiana. Geologically the coal fields in those two States and in western Kentucky form one great region. Within the last few years shippers of western Kentucky coal, following up the opportunity afforded them when the United States Fuel Administration zoned this coal into Chicago territory, have made an active fight for Chicago trade. When the strike shut off shipments from Illinois and Indiana mines, western Kentucky naturally had the first call on that market.

The other States that made new records of maximum output in 1922 were North Carolina and North Dakota. North Carolina, with a production of 78,570 tons, showed an increase of 235.2 per cent over 1921. North Dakota, with an putput of 1,327,564 tons, showed

an increase of 53.5 per cent. This increase is undoubtedly the more significant of the two, as the history of production in North Carolina has been both checkered and intermittent. North Dakota, on the other hand, has shown a fairly constant growth, the rate of which promises to become accentuated by the commercial and scientific developments touched upon in the summary of the production of this State on page 612 of this report.

Six States made their maximum records in 1920—Ohio, Oklahoma, Utah, Virginia, West Virginia, and Wyoming. Seven States—Illinois, Indiana, Kansas, Montana, New Mexico, Pennsylvania, and Washington—made their maximum production in 1918. Alabama, Colorado, Iowa, and Missouri reached their largest output in 1917; Texas in 1913; Arkansas, Maryland, and Michigan in 1907; Tennessee in 1910; and South Dakota in 1919. Production in California and Oregon was at its peak in 1880, their oldest year of record. The figures of the maximum production for all States are included in the following table:

Coal produced in the United States in 1922, by States, and highest recorded production.

State.	1922 (net tons).	Maximum production.		State.	1922 (net tons).	Maximum production.	
		Year.	Net tons.			Year.	Net tons.
Alabama	18,324,740	1917	20,068,074	North Carolina	78,570	1922	78,570
Alaska	79,275	1922	79,275	North Dakota	1,327,564	1922	1,327,564
Arkansas	1,110,046	1907	2,670,438	Ohio	26,953,791	1920	45,878,191
California, Idaho, and Oregon	26,893	1880	[a] 280,155	Oklahoma	2,802,511	1920	4,849,288
Colorado	10,019,597	1917	12,483,336	Pennsylvania (bituminous)	113,148,308	1918	178,550,741
Georgia	60,636	1903	416,951	South Dakota	7,752	1919	14,417
Illinois	58,467,736	1918	89,291,105	Tennessee	4,876,774	1910	7,121,380
Indiana	19,132,889	1918	30,678,634	Texas	1,106,007	1913	2,429,144
Iowa	4,335,161	1917	8,965,830	Utah	4,992,008	1920	6,005,199
Kansas	2,955,170	1918	7,561,947	Virginia	10,491,174	1920	11,378,606
Kentucky	42,134,175	1922	42,134,175	Washington	2,581,165	1918	4,082,212
Maryland	1,222,707	1907	5,532,628	West Virginia	80,488,192	1920	89,970,707
Michigan	929,390	1907	2,035,858	Wyoming	5,971,724	1920	9,630,271
Missouri	2,924,750	1917	5,670,549	Pennsylvania (anthracite)	54,683,022	1917	99,611,811
Montana	2,572,221	1918	4,532,505				
New Mexico	3,147,173	1918	4,023,239				

[a] California and Oregon only.

MONTHLY AND WEEKLY PRODUCTION.

The following tables form a summary of the statistics of the monthly and weekly production of anthracite and bituminous coal that were first published in the Geological Survey's weekly coal reports. The figures given are estimates based upon weekly and daily reports of cars of coal and beehive coke loaded by the principal coal-carrying roads. They are afterward revised to agree with the results of the annual statistical reports from the producers of coal, and therefore the figures here given differ slightly from the estimates originally issued in the weekly reports.

To check the estimates of monthly production of anthracite an additional source of information is available in the monthly reports of shipments made by the Anthracite Bureau of Information.

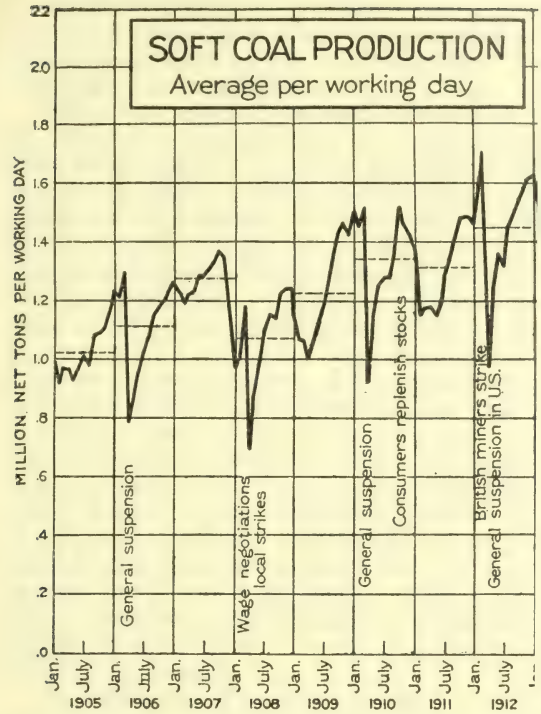
MONTHLY PRODUCTION OF BITUMINOUS COAL.

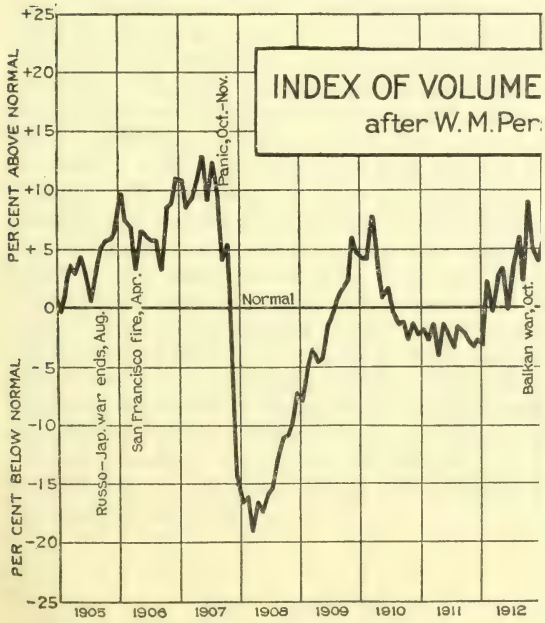
Comparisons of total production in months of unequal length, such as February and March, are misleading. A better comparative measure is the average production per working day. It is the average production per working day that is plotted in the upper half of the accompanying diagram (Pl. III), which brings to view the monthly fluctuations in the output of bituminous coal from 1905 to 1922. The ups and downs of the curve of coal output in the upper half of the diagram are largely explained by the fluctuations in the index curve of trade shown in the lower half. That index, prepared by Prof. W. M. Persons and published in the Review of Economic Statistics, April, 1923, is designed to indicate the condition of general business in the country. It gives weight to a number of factors, including trade, transportation, manufacturing activity, and industrial employment. The curve indicates the percentage above or below the normal for each month, and in the calculation of this normal the factors of seasonal variation and year to year growth have been eliminated. The position of the curve for any one month therefore indicates how far the barometer of business was above or below the average or normal line at that time. (The dotted lines paralleling the main curve in 1915 and 1919 are alternative values of the index, derived from a different set of business items.)

Now, the production of bituminous coal is largely affected by the general state of business, because 73 per cent of the output is consumed by railroads, manufacturing establishments, and other industrial users. It is to be expected, therefore, that the curve of coal output should respond to the significant changes in the index of trade. Thus it is that in years of business activity, when the index is well above the normal line, the general level of coal production, as indicated by the broken horizontal line of average output for the year, commonly shows an increase. Conversely, the average level of coal production for the depression years 1908, 1914–15, and 1921 shows a sharp decrease.

The diagrams also bring out the existence of other factors that are scarcely less important than the general state of trade, in explaining the output of coal during a given month. The demand for coal is distinctly seasonal. In the pre-war years a definite seasonal rhythm may be observed which can be read most clearly in the "odd" years of no wage negotiation—for instance, 1913. During the war the spring and summer decline was obscured by the abnormal demand of the munitions industries, but in the post-war years it has again appeared.

The most characteristic features of the curve of bituminous output are the recurring peaks and valleys of the "even" years, when the wage agreements expire. It was characteristic of the pre-war even years for production to cease in the districts of the central competitive field for one, two, or three months, or even longer. In anticipation of a shortage consumers bought heavily for storage in the months preceding the suspension. It was a strike also that produced the extraordinary peak and valley in the fall of 1919, and the tremendous effect of the strike of 1922 is registered in the fact that production in April of that year reached the lowest point during the 18 years covered by the record.





MONTHLY FLUCTUATIONS IN OUTPUT OF BIT
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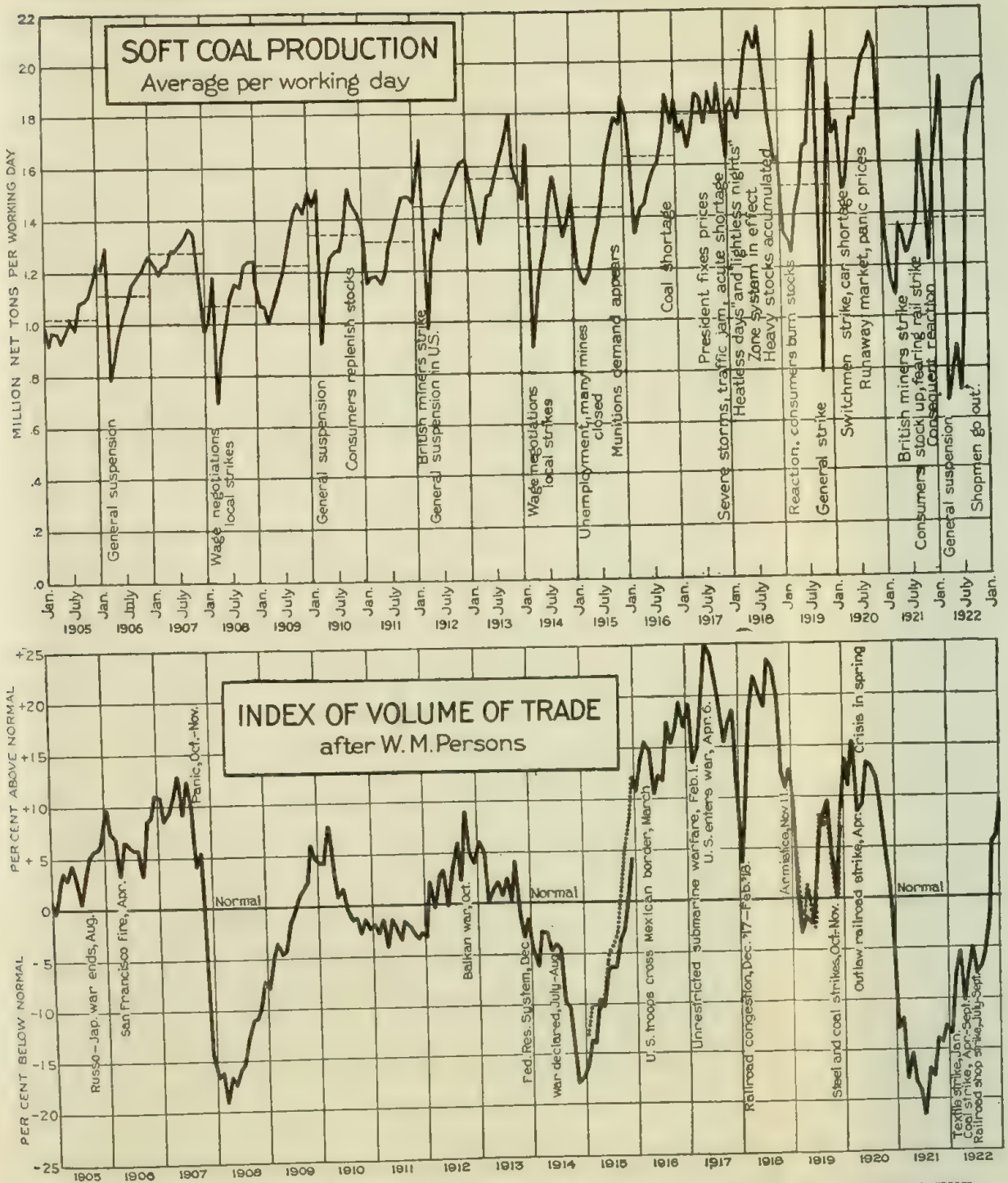


MONTHLY FLUCTUATIONS IN OUTPUT OF BITUMINOUS COAL AND IN VOLUME OF TRADE IN THE UNITED STATES, 1905–1922.

Because of these violent fluctuations associated with strikes and with the ebb and flow of coal in and out of storage, the curve of soft-coal production is not a satisfactory barometer of business. The consumption of coal is probably as sensitive a measure of the activity of business at large as could be obtained, but production is here not equivalent to consumption.

When not affected by such disturbing factors as strikes or acute shortage of transportation, the production of bituminous coal has responded quickly to sharp changes in the state of trade. Thus, during the panic of October-November, 1907, the production of coal began to drop sharply at practically the same time as the index of trade. Again, the depression of late 1913 and early 1914 was quickly apparent in the coal trade, though veiled by the threat of a suspension on the termination of the wage agreement. But in other years like 1910 or 1920, when some external cause, such as a big strike or a congestion of the railroads, happened to be effective at the time the business crisis appeared, the response of the coal market was long delayed. Under such circumstances the bituminous-coal industry might continue to feel an artificial prosperity after other industries had begun to slacken their pace, simply because consumers had burned up their stocks and felt that they must replenish them. Thus it was that after August, 1920, although general business began to decline sharply, the coal men continued to experience the most golden boom in the history of their business. Prices of coal did not approach normal levels until December, and slackening of output was not really apparent until January or February of 1921. Much the same condition occurred in the year 1910, the later part of which was marked by mild depression.

The statistics of monthly production for 1905 to 1912, given herewith, like those already published for the later years, are based upon records of bituminous coal and beehive coke loaded for shipment by the principal carriers. In collaboration with the President's Conference on Unemployment, the Geological Survey obtained from the important carriers, records of monthly shipments back to 1905. With these as a base the total quantity of raw coal loaded at the mines for shipment, sold to local trade, and burned for mine fuel has been prorated on the assumption that the distribution by months of the total production would be the same as the distribution by months of the recorded shipments of the reporting roads. In like manner the total quantity of coal made into coke at the mines has been prorated between the several months in accordance with the shipments of coke out of the Connellsville region for the years 1905 to 1911 and in accordance with the quantity of coke loaded monthly by all the principal carriers for the years beginning with 1912. The resulting estimates are obviously not precise, but the margin of error they contain is not so great as to impair their usefulness in indicating the magnitude of the monthly variations in bituminous-coal production, whether caused by the seasonal character of demand or the irregularities of car and labor supply.

Bituminous coal produced in the United States, by months, and average production per working day, 1905–1922, in net tons.

Month.	1905		1906		1907	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	24, 911, 000	996, 000	32, 111, 000	1, 235, 000	32, 936, 000	1, 267, 000
February	22, 197, 000	925, 000	29, 248, 000	1, 219, 000	29, 533, 000	1, 231, 000
March	26, 430, 000	979, 000	35, 147, 000	1, 302, 000	31, 179, 000	1, 199, 000
April	24, 293, 000	972, 000	19, 823, 000	793, 000	31, 740, 000	1, 221, 000
May	25, 289, 000	937, 000	23, 458, 000	869, 000	33, 114, 000	1, 226, 000
June	25, 277, 000	972, 000	25, 022, 000	962, 000	32, 383, 000	1, 295, 000
July	25, 369, 000	1, 015, 000	25, 847, 000	1, 034, 000	33, 531, 000	1, 290, 000
August	26, 585, 000	985, 000	29, 175, 000	1, 080, 000	35, 526, 000	1, 316, 000
September	28, 166, 000	1, 083, 000	28, 925, 000	1, 157, 000	33, 374, 000	1, 335, 000
October	28, 403, 000	1, 092, 000	32, 013, 000	1, 186, 000	37, 061, 000	1, 373, 000
November	28, 945, 000	1, 113, 000	31, 199, 000	1, 200, 000	35, 056, 000	1, 348, 000
December	29, 198, 000	1, 168, 000	30, 907, 000	1, 236, 000	29, 326, 000	1, 173, 000
	315, 063, 000	1, 020, 000	342, 875, 000	1, 106, 000	394, 759, 000	1, 273, 000

Month.	1908		1909		1910	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	25, 535, 000	982, 000	28, 856, 000	1, 154, 000	37, 566, 000	1, 503, 000
February	25, 344, 000	1, 014, 000	25, 837, 000	1, 077, 000	34, 971, 000	1, 457, 000
March	30, 739, 000	1, 182, 000	28, 862, 000	1, 069, 000	41, 006, 000	1, 519, 000
April	18, 253, 000	702, 000	26, 227, 000	1, 009, 000	23, 898, 000	919, 000
May	22, 627, 000	870, 000	27, 910, 000	1, 073, 000	30, 003, 000	1, 154, 000
June	25, 656, 000	987, 000	29, 632, 000	1, 140, 000	32, 809, 000	1, 262, 000
July	28, 525, 000	1, 097, 000	31, 093, 000	1, 196, 000	32, 027, 000	1, 281, 000
August	29, 991, 000	1, 154, 000	33, 361, 000	1, 283, 000	34, 633, 000	1, 283, 000
September	29, 546, 000	1, 136, 000	35, 659, 000	1, 372, 000	35, 441, 000	1, 363, 000
October	33, 073, 000	1, 225, 000	37, 277, 000	1, 434, 000	39, 593, 000	1, 523, 000
November	31, 009, 000	1, 240, 000	38, 020, 000	1, 462, 000	38, 120, 000	1, 466, 000
December	32, 276, 000	1, 241, 000	37, 010, 000	1, 423, 000	37, 044, 000	1, 425, 000
	332, 574, 000	1, 069, 000	379, 744, 000	1, 225, 000	417, 111, 000	1, 346, 000

Month.	1911		1912		1913	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	34, 278, 000	1, 371, 000	38, 047, 000	1, 463, 000	42, 274, 000	1, 626, 000
February	27, 660, 000	1, 153, 000	39, 368, 000	1, 575, 000	37, 057, 000	1, 544, 000
March	31, 840, 000	1, 179, 000	44, 243, 000	1, 702, 000	37, 536, 000	1, 444, 000
April	29, 565, 000	1, 183, 000	25, 580, 000	984, 000	34, 169, 000	1, 314, 000
May	31, 121, 000	1, 153, 000	33, 561, 000	1, 243, 000	37, 205, 000	1, 378, 000
June	31, 207, 000	1, 200, 000	34, 291, 000	1, 372, 000	37, 405, 000	1, 496, 000
July	32, 383, 000	1, 295, 000	34, 660, 000	1, 333, 000	38, 858, 000	1, 495, 000
August	36, 555, 000	1, 354, 000	39, 346, 000	1, 457, 000	41, 590, 000	1, 600, 000
September	36, 657, 000	1, 410, 000	37, 404, 000	1, 496, 000	41, 424, 000	1, 657, 000
October	38, 570, 000	1, 483, 000	42, 030, 000	1, 557, 000	46, 164, 000	1, 710, 000
November	38, 777, 000	1, 491, 000	41, 238, 000	1, 586, 000	43, 233, 000	1, 801, 000
December	37, 294, 000	1, 492, 000	40, 337, 000	1, 613, 000	41, 519, 000	1, 597, 000
	405, 907, 000	1, 314, 000	450, 105, 000	1, 447, 000	478, 434, 000	1, 553, 000

Bituminous coal produced in the United States, by months, and average production per working day, 1905–1922, in net tons—Continued.

Month.	1914		1915		1916	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	40, 191, 000	1, 546, 000	37, 194, 000	1, 488, 000	46, 593, 000	1, 864, 000
February	35, 472, 000	1, 478, 000	29, 321, 000	1, 222, 000	45, 187, 000	1, 807, 000
March	45, 455, 000	1, 684, 000	31, 801, 000	1, 178, 000	43, 828, 000	1, 623, 000
April	23, 609, 000	908, 000	29, 968, 000	1, 153, 000	33, 628, 000	1, 345, 000
May	28, 551, 000	1, 098, 060	30, 938, 000	1, 190, 000	38, 804, 000	1, 437, 000
June	31, 412, 000	1, 208, 000	33, 957, 000	1, 306, 000	37, 742, 000	1, 452, 000
July	34, 305, 000	1, 319, 000	35, 573, 000	1, 368, 000	38, 113, 000	1, 525, 000
August	37, 751, 000	1, 452, 000	38, 161, 000	1, 468, 000	42, 696, 000	1, 581, 000
September	39, 019, 000	1, 561, 000	40, 964, 000	1, 639, 000	42, 098, 000	1, 619, 000
October	37, 685, 000	1, 449, 000	44, 198, 000	1, 700, 000	44, 807, 000	1, 723, 000
November	33, 392, 000	1, 336, 000	44, 737, 000	1, 789, 000	44, 927, 000	1, 872, 000
December	35, 862, 000	1, 379, 000	45, 814, 000	1, 762, 000	44, 097, 000	1, 764, 000
	422, 704, 000	1, 368, 000	442, 626, 000	1, 437, 000	502, 520, 000	1, 632, 000

Month.	1917		1918		1919	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	47, 969, 000	1, 845, 000	42, 227, 000	1, 624, 000	42, 193, 000	1, 623, 000
February	41, 353, 000	1, 723, 000	43, 777, 000	1, 824, 000	32, 103, 000	1, 338, 000
March	47, 869, 000	1, 773, 000	48, 113, 000	1, 851, 000	34, 293, 000	1, 319, 000
April	41, 854, 000	1, 674, 000	46, 041, 000	1, 771, 000	32, 712, 000	1, 258, 000
May	47, 086, 000	1, 744, 000	50, 443, 000	1, 868, 000	38, 186, 000	1, 414, 000
June	46, 824, 000	1, 873, 000	51, 138, 000	2, 046, 000	37, 685, 000	1, 507, 000
July	46, 292, 000	1, 852, 000	54, 971, 000	2, 114, 000	43, 425, 000	1, 670, 000
August	47, 372, 000	1, 755, 000	55, 114, 000	2, 041, 000	43, 613, 000	1, 677, 000
September	45, 108, 000	1, 880, 000	51, 183, 000	2, 133, 000	48, 209, 000	1, 928, 000
October	48, 337, 000	1, 790, 000	52, 300, 000	1, 937, 000	57, 200, 000	2, 119, 000
November	47, 690, 000	1, 908, 000	43, 895, 000	1, 756, 000	19, 006, 000	792, 000
December	44, 037, 000	1, 761, 000	40, 184, 000	1, 607, 000	37, 235, 000	1, 432, 000
	551. 791, 000	1, 797, 000	579, 386, 000	1, 881, 000	465, 860, 000	1, 512, 000

Month.	1920		1921		1922	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	49, 748, 000	1, 913, 000	41, 148, 000	1, 646, 000	38, 930, 000	1, 545, 000
February	41, 055, 000	1, 711, 000	31, 524, 000	1, 314, 000	42, 425, 000	1, 768, 000
March	47, 850, 000	1, 772, 000	31, 054, 000	1, 150, 000	51, 936, 000	1, 924, 000
April	38, 764, 000	1, 491, 000	28, 154, 000	1, 083, 000	16, 335, 000	672, 000
May	39, 841, 000	1, 532, 000	34, 057, 000	1, 362, 000	21, 005, 000	784, 000
June	46, 095, 000	1, 773, 000	34, 635, 000	1, 332, 000	23, 096, 000	888, 000
July	45, 988, 000	1, 769, 000	31, 047, 000	1, 242, 000	17, 602, 000	704, 000
August	49, 974, 000	1, 922, 000	35, 291, 000	1, 307, 000	26, 755, 000	991, 000
September	50, 241, 000	2, 010, 000	35, 870, 000	1, 380, 000	42, 463, 000	1, 678, 000
October	53, 278, 000	2, 049, 000	44, 687, 000	1, 719, 000	46, 733, 000	1, 797, 000
November	52, 576, 000	2, 103, 000	36, 805, 000	1, 472, 000	46, 900, 000	1, 899, 000
December	53, 257, 000	2, 048, 000	31, 650, 000	1, 217, 000	48, 088, 000	1, 924, 000
	568, 667, 000	1, 847, 000	415, 922, 000	1, 356, 000	422, 268, 000	1, 379, 000

MONTHLY PRODUCTION OF ANTHRACITE.

The curve of monthly production of anthracite, shown in Plate IV, is less affected by the ebb and flow of prosperity than that of bituminous coal, because anthracite is primarily a domestic rather than an industrial fuel. The anthracite curve also lacks the

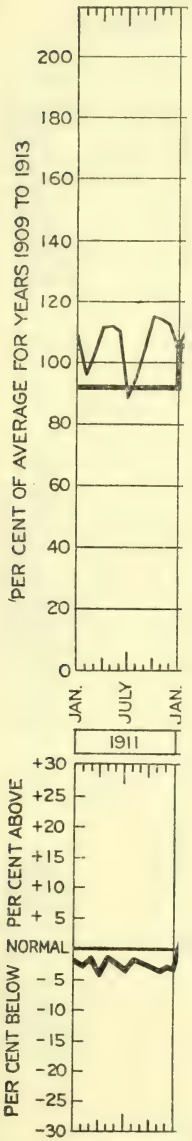
element of year to year growth characteristic of the curve for bituminous coal. In the last 10 years there has been practically no increase in the output of the domestic sizes of anthracite, and the supply is therefore failing to keep pace with the growth of the country, as indicated by the line of volume of all manufactures shown in the upper part of the diagram. However, the anthracite curve is not lacking in characteristic fluctuations of its own. Two slight seasonal depressions occur in most of the years—one in late winter or early spring, the other in midsummer. Again, though strikes are less frequent in the anthracite region than in the bituminous fields, the stoppage they entail is more complete. The diagram shows the sudden drops attending the suspension of April, 1912, and the "vacation strike" of September, 1920. The downward jog in the first quarter of 1919 was due in part to unusually mild weather, in part to the reaction of the coal market to the increased demands of the war.

The most conspicuous feature of the curve, however, is the canyon-like drop that marks the great suspension of 1922. The strike which halted the production of freshly mined anthracite from April 1 to September 11, 1922, makes it impossible to consider the daily average output for the year fairly comparable with the averages shown for the preceding 11 years. During 135 days out of the 303 working days in 1922 the aggregate production was only 494,000 net tons—a total equivalent to considerably less than the output for two working days under normal conditions of operation. For the 168 days not covered by the general strike the average daily production was 323,000 tons. This adjusted average closely approximates the daily averages for 1917 and 1918, the years of record output in the hard-coal region of Pennsylvania.

Anthracite produced in the United States, by months, and average production per working day, 1911–1922, in net tons.

[Estimated from monthly shipments as reported by Anthracite Bureau of Information; includes mine fuel, coal sold locally, washery and dredge coal, and output of Sullivan County.]

Month.	1911		1912		1913	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	7,635,000	305,000	7,644,000	294,000	8,396,000	323,000
February	6,558,000	273,000	7,793,000	312,000	7,519,000	313,000
March	7,755,000	287,000	8,713,000	335,000	6,505,000	250,000
April	7,507,000	313,000	354,000	14,000	7,906,000	304,000
May	8,170,000	314,000	1,896,000	73,000	7,945,000	294,000
June	8,038,000	309,000	8,211,000	328,000	7,911,000	316,000
July	6,213,000	249,000	8,335,000	321,000	7,272,000	280,000
August	7,154,000	265,000	8,722,000	323,000	7,116,000	274,000
September	7,411,000	296,000	7,793,000	325,000	7,384,000	295,000
October	8,107,000	324,000	8,840,000	340,000	8,399,000	311,000
November	8,008,000	320,000	8,177,000	327,000	7,668,000	320,000
December	7,908,000	316,000	7,884,000	315,000	7,504,000	289,000
	90,464,000	298,000	84,362,000	276,000	91,525,000	297,000



MONTHLY FI

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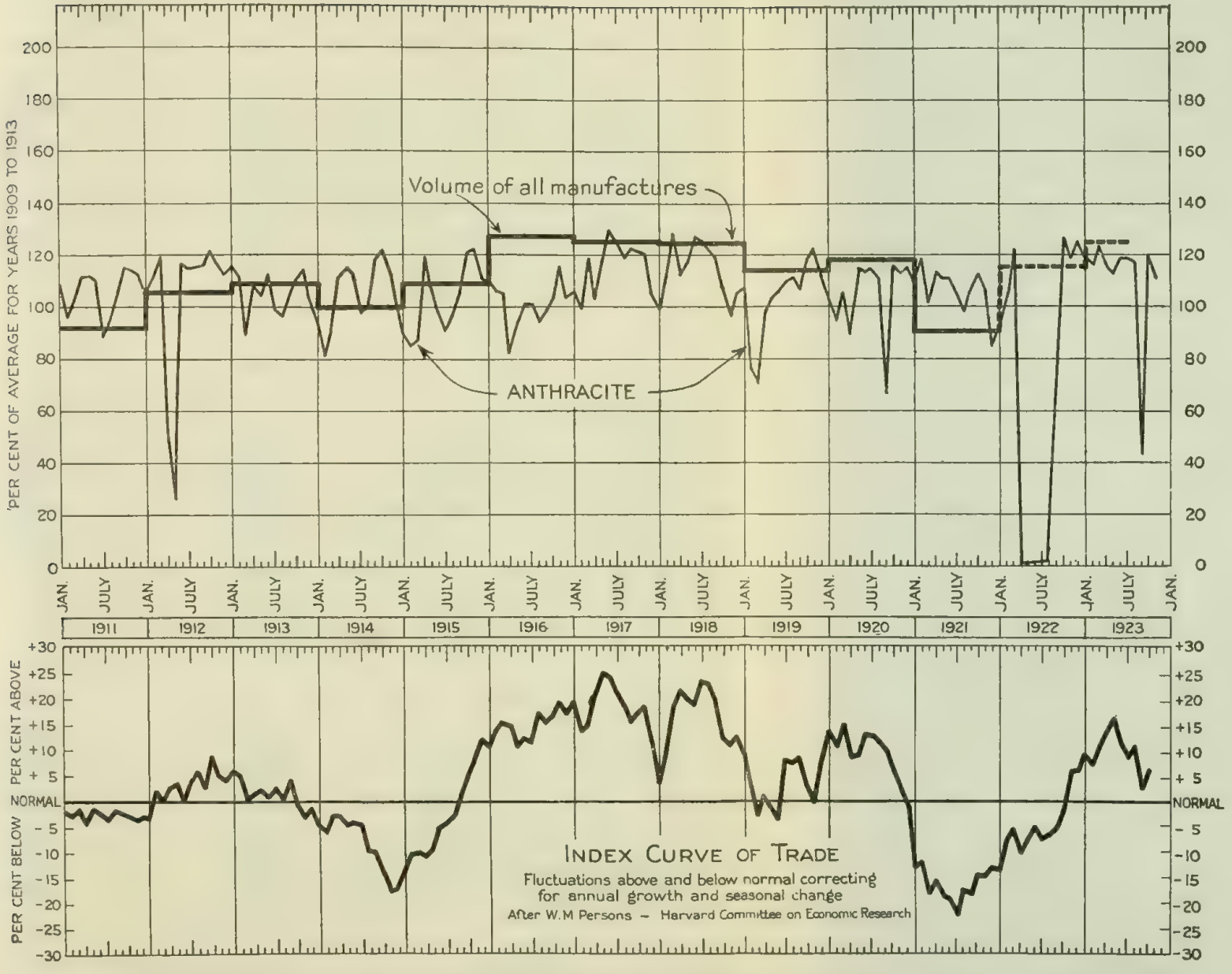

PER CENT OF AVERAGE FOR YEARS 1909 TO 1913
Volume of all manufactures
ANTHRACITE
JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN. JULY JAN.
1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923
PER CENT ABOVE NORMAL PER CENT BELOW
INDEX CURVE OF TRADE
Fluctuations above and below normal correcting for annual growth and seasonal change
After W.M Persons – Harvard Committee on Economic Research

MONTHLY FLUCTUATIONS IN OUTPUT OF ANTHRACITE COMPARED WITH CHANGES IN INDEX OF TRADE AND IN VOLUME OF ALL MANUFACTURES, 1911-1923.

The index of trade in the lower diagram represents percentage above or below normal. The heavy line in the upper diagram represents the physical volume of all manufactures for each year, the average for the five years 1909 to 1913 being taken as 100 per cent. The curve of anthracite represents average production per working day (including washery and dredge coal), expressed as a percentage of the average for the five years 1909 to 1913.

Anthracite produced in the United States, by months, and average production per working day, 1911–1922, in net tons—Continued.

Month.	1914		1915		1916	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	6,878,000	265,000	6,337,000	253,000	7,649,000	306,000
February	5,477,000	228,000	5,703,000	238,000	7,404,000	296,000
March	6,863,000	254,000	6,654,000	246,000	7,964,000	295,000
April	8,069,000	310,000	8,725,000	336,000	5,887,000	235,000
May	8,348,000	321,000	7,807,000	300,000	7,212,000	267,000
June	8,147,000	313,000	7,157,000	275,000	7,327,000	282,000
July	7,165,000	276,000	6,691,000	257,000	7,062,000	282,000
August	7,288,000	280,000	7,161,000	275,000	7,190,000	266,000
September	8,301,000	332,000	7,423,000	297,000	7,206,000	277,000
October	8,830,000	340,000	8,761,000	337,000	7,630,000	293,000
November	7,878,000	315,000	8,514,000	341,000	7,790,000	325,000
December	7,578,000	291,000	8,062,000	310,000	7,257,000	290,000
	90,822,000	294,000	88,995,000	289,000	87,578,000	284,000

Month.	1917		1918		1919	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	7,672,000	295,000	7,270,000	280,000	7,819,000	301,000
February	6,688,000	279,000	7,494,000	312,000	5,102,000	213,000
March	9,026,000	334,000	9,382,000	361,000	5,190,000	200,000
April	7,222,000	289,000	8,211,000	316,000	6,884,000	275,000
May	8,933,000	331,000	8,880,000	329,000	7,525,000	289,000
June	9,103,000	364,000	8,855,000	354,000	7,404,000	296,000
July	8,684,000	347,000	9,134,000	351,000	7,974,000	307,000
August	9,058,000	335,000	9,258,000	343,000	8,096,000	311,000
September	8,230,000	343,000	8,038,000	335,000	7,494,000	300,000
October	9,183,000	340,000	8,105,000	300,000	8,645,000	333,000
November	8,453,000	338,000	6,803,000	272,000	7,870,000	342,000
December	7,360,000	294,000	7,396,000	296,000	8,089,000	311,000
	99,612,000	324,000	98,826,000	321,000	88,092,000	290,000

Month.	1920		1921		1922	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	7,459,000	287,000	7,681,000	307,000	6,566,000	263,000
February	6,415,000	267,000	7,983,000	333,000	7,096,000	296,000
March	7,935,000	294,000	7,677,000	284,000	9,181,000	340,000
April	6,285,000	251,000	7,985,000	319,000	27,000	1,000
May	8,037,000	321,000	7,752,000	310,000	36,000	1,000
June	8,251,000	317,000	8,071,000	310,000	86,000	3,000
July	8,342,000	321,000	7,309,000	292,000	118,000	5,000
August	8,105,000	312,000	7,459,000	276,000	164,000	6,000
September	4,691,000	188,000	7,385,000	295,000	5,075,000	203,000
October	8,148,000	326,000	7,858,000	314,000	8,896,000	356,000
November	7,527,000	314,000	7,110,000	296,000	8,695,000	362,000
December	8,403,000	323,000	6,203,000	239,000	8,743,000	350,000
	89,598,000	295,000	90,473,000	298,000	54,683,000	180,000

WEEKLY PRODUCTION OF BITUMINOUS COAL.

The extreme fluctuations in the production of bituminous coal appear even more sharp when viewed on a weekly basis, as in the following tables. (See fig. 18.) The highest point reached during the period over which records of weekly output extend was 13,344,000 tons, in the week of October 25, 1919, the last full-time week before

the strike of that year. The lowest point of record was 3,638,000 tons, only two weeks later, during the week of November 8, 1919, when the strike had reached its maximum effectiveness. A similar violent fluctuation in weekly output marked the strike of 1922, though the extremes were not as great. The lowest point in any full-time week was 3,701,000 tons, in the week ending April 22, and the highest point was 11,900,000 tons, in the week ending December 9. A still higher mark would no doubt have been attained, had not the shopmen's strike handicapped the railroads, for the demand for coal after the settlement of the miners' strike was sufficient to absorb all that could be transported.

Bituminous coal produced in the United States, by weeks, 1920–1922.

1920		1921		1922	
Week ending—	Net tons.	Week ending—	Net tons.	Week ending—	Net tons.
Jan. 3[a]	4,243,000	Jan. 1[a]	282,000	Jan. 7	7,739,000
10	11,583,000	8	11,000,000	14	8,594,000
17	11,771,000	15	10,154,000	21	9,091,000
24	10,704,000	22	9,386,000	28	9,953,000
31	10,837,000	29	8,758,000	Feb. 4	10,056,000
Feb. 7	10,239,000	Feb. 5	8,311,000	11	10,672,000
14	10,724,000	12	8,032,000	18	10,647,000
21	9,731,000	19	7,655,000	25	10,768,000
28	10,352,000	26	7,595,000	Mar. 4	10,912,000
Mar. 6	10,540,000	Mar. 5	7,438,000	11	11,493,000
13	10,512,000	12	7,052,000	18	11,225,000
20	10,585,000	19	6,655,000	25	11,851,000
27	11,267,000	26	6,599,000	Apr. 1	10,838,000
Apr. 3	9,938,000	Apr. 2	5,950,000	8	3,970,000
10	9,912,000	9	6,254,000	15	3,785,000
17	7,736,000	16	6,671,000	22	3,701,000
24	8,718,000	23	6,965,000	29	4,322,000
May 1	9,133,000	30	7,137,000	May 6	4,311,000
8	9,377,000	May 7	7,553,000	13	4,589,000
15	8,965,000	14	8,185,000	20	4,639,000
22	9,458,000	21	8,165,000	27	5,061,000
29	9,787,000	28	8,345,000	June 3	4,779,000
June 5	9,350,000	June 4	6,985,000	10	5,317,000
12	10,592,000	11	8,186,000	17	5,189,000
19	10,326,000	18	7,717,000	24	5,552,000
26	10,798,000	25	7,873,000	July 1	5,410,000
July 3	10,522,000	July 2	7,826,000	8	3,807,000
10	9,880,000	9	6,300,000	15	4,268,000
17	11,129,000	16	7,564,000	22	3,822,000
24	10,710,000	23	7,542,000	29	4,091,000
31	9,586,000	30	7,480,000	Aug. 5	4,465,000
Aug. 7	10,671,000	Aug. 6	7,344,000	12	4,768,000
14	12,084,000	13	7,942,000	19	4,772,000
21	11,292,000	20	7,877,000	26	6,973,000
28	11,644,000	27	7,923,000	Sept. 2	9,688,000
Sept. 4	11,423,000	Sept. 3	7,773,000	9	9,100,000
11	10,930,000	10	7,240,000	16	10,080,000
18	11,921,000	17	8,367,000	23	10,090,000
25	12,123,000	24	8,714,000	30	10,168,000
Oct. 2	11,610,000	Oct. 1	9,085,000	Oct. 7	10,079,000
9	12,380,000	8	9,335,000	14	10,466,000
16	12,387,000	15	9,924,000	21	10,743,000
23	12,512,000	22	11,292,000	28	11,059,000
30	12,691,000	29	11,197,000	Nov. 4	11,041,000
Nov. 6	11,691,000	Nov. 5	9,532,000	11	10,504,000
13	12,410,000	12	8,781,000	18	11,610,000
20	11,961,000	19	9,066,000	25	11,491,000
27	11,751,000	26	7,257,000	Dec. 2	10,753,000
Dec. 4	13,106,000	Dec. 3	7,261,000	9	11,900,000
11	13,160,000	10	7,473,000	16	11,042,000
18	12,435,000	17	7,218,000	23	10,495,000
25	9,908,000	24	7,614,000	30	10,529,000
Jan. 1[a]	9,572,000	31	6,092,000		422,268,000
	568,667,000		415,922,000		

[a] Figures represent that part of the output in the week which is included in the calendar year shown. The figures of total production for these weeks are as follows: Jan. 3, 1920, 11,,264,000 tons; Jan. 1, 1921, 9,854.000.

To compare the trend of production in a week containing a holiday with that in a full week of six working days recourse must be had to the average output per working day. In the accompanying table is given the number of working days in each week of the last three years and the average daily production. The figures, it should be noted, represent bituminous coal only.

The number of days in the working year is not the same in all districts. All mines observe Sundays, Fourth of July, and Christmas, and the great majority of the mines observe New Year's Day, although under exceptional circumstances, as in 1920 and 1922, considerable coal may be loaded on New Year's Day. There are other holidays, such as Eight-hour Day (April 1) and Labor Day, that are very generally observed in union districts but not in nonunion districts, and such days are equivalent over the country as a whole to about three-tenths of a full working day. Similar variations have been noted in the observance of Memorial Day and Thanksgiving Day. After allowance is made for these holidays, the weighted average potential working year for the country as a whole is 308 days. Other special holidays, such as a presidential-election day or a draft-registration day, may cut the working year still further. If Armistice Day is to be generally observed hereafter, the working year will average about 307 days. In 1920 the day counted for seven-tenths of a full day and in 1921 and 1922 for five-tenths. The year 1922 had only 306.3 working days, because the year both began and ended on a Sunday.

On other days, such as the birthdays of Lincoln and Washington and the church holy days, the bituminous mines are not generally closed, and these days have therefore been counted in the table as working days. Individual mines may close on such days, and the whole output of a district may show a perceptible decrease, but the records of daily loadings of coal in cars reported by the railroads do not indicate a sufficiently large or sufficiently regular decrease to warrant recognizing them as cutting into the potential working year. These conclusions are based upon weekly reports of time worked and lost by the mines for the six years 1917 to 1922 and upon weekly and daily records of cars loaded by the railroads.

Number of working days and average production of bituminous coal per working day in each week, 1920–1922.

1920			1921			1922		
Week ending—	Number of working days.	Average production (net tons).	Week ending—	Number of working days.	Average production (net tons).	Week ending—	Number of working days.	Average production (net tons).
Jan. 3	[a] 2.3	[b] 2,130,000	Jan. 1	[a] 0.2	[b] 1,898,000	Jan. 7	5.2	1,488,000
10	6	1,931,000	8	6	1,834,000	14	6	1,432,000
17	6	1,962,000	15	6	1,693,000	21	6	1,515,000
24	6	1,784,000	22	6	1,565,000	28	6	1,659,000
31	6	1,807,000	29	6	1,460,000			
Feb. 7	6	1,707,000	Feb. 5	6	1,385,000	Feb. 4	6	1,676,000
14	6	1,788,000	12	6	1,339,000	11	6	1,779,000
21	6	1,622,000	19	6	1,276,000	18	6	1,775,000
28	6	1,726,000	26	6	1,266,000	25	6	1,795,000
Mar. 6	6	1,757,000	Mar. 5	6	1,240,000	Mar. 4	6	1,819,000
13	6	1,752,000	12	6	1,176,000	11	6	1,916,000
20	6	1,765,000	19	6	1,109,000	18	6	1,871,000
27	6	1,878,000	26	6	1,100,000	25	6	1,975,000
Apr. 3	5.3	1,880,000	Apr. 2	5.3	1,123,000	Apr. 1	5.3	2,045,000
10	6	1,652,000	9	6	1,043,000	8	6	662,000
17	6	1,290,000	16	6	1,112,000	15	6	631,000
24	6	1,453,000	23	6	1,161,000	22	6	617,000
			30	6	1,190,000	29	6	720,000
May 1	6	1,522,000	May 7	6	1,259,000	May 6	6	719,000
8	6	1,563,000	14	6	1,364,000	13	6	765,000
15	6	1,494,000	21	6	1,361,000	20	6	773,000
22	6	1,578,000	28	6	1,391,000	27	6	844,000
29	6	1,631,000						
June 5	5.5	1,700,000	June 4	5.2	1,341,000	June 3	5.8	824,000
12	6	1,766,000	11	6	1,365,000	10	6	886,000
19	6	1,721,000	18	6	1,286,000	17	6	865,000
26	6	1,800,000	25	6	1,312,000	24	6	925,000
July 3	6	1,754,000	July 2	6	1,305,000	July 1	6	902,000
10	5	1,976,000	9	5	1,260,000	8	5	761,000
17	6	1,855,000	16	6	1,261,000	15	6	711,000
24	6	1,785,000	23	6	1,257,000	22	6	637,000
31	6	1,598,000	30	6	1,247,000	29	6	682,000
Aug. 7	6	1,779,000	Aug. 6	6	1,224,000	Aug. 5	6	744,000
14	6	2,014,000	13	6	1,324,000	12	6	795,000
21	6	1,882,000	20	6	1,313,000	19	6	795,000
28	6	1,941,000	27	6	1,321,000	26	6	1,162,000
Sept. 4	6	1,904,000	Sept. 3	6	1,296,000	Sept. 2	6	1,615,000
11	5.3	2,062,000	10	5.3	1,366,000	9	5.3	1,717,000
18	6	1,987,000	17	6	1,395,000	16	6	1,680,000
25	6	2,021,000	24	6	1,453,000	23	6	1,682,000
						30	6	1,695,060
Oct. 2	6	1,935,000	Oct. 1	6	1,514,000	Oct. 7	6	1,680,000
9	6	2,064,000	8	6	1,556,000	14	6	1,744,000
16	6	2,065,000	15	6	1,654,000	21	6	1,791,000
23	6	2,086,000	22	6	1,882,000	28	6	1,843,000
30	6	2,116,000	29	6	1,867,000			
Nov. 6	5.5	2,120,000	Nov. 5	6	1,589,000	Nov. 4	6	1,840,000
13	5.7	2,170,000	12	5.5	1,597,000	11	5.5	1,910,000
20	6	1,994,000	19	6	1,511,000	18	6	1,935,000
27	5.3	2,214,000	26	5.3	1,372,000	25	6	1,915,000
Dec. 4	6	2,185,000	Dec. 3	6	1,210,000	Dec. 2	5.2	2,068,000
11	6	2,194,000	10	6	1,246,000	9	6	1,983,000
18	6	2,073,000	17	6	1,263,000	16	6	1,840,000
25	5.0	1,982,000	24	6	1,269,000	23	6	1,749,000
Jan. 1	[a] 5.0	[b] 1,898,000	31	[a] 5	[b] 1,218,000	30	5	2,106,000
Total	307.9	1,847,000		306.8	1,356,000		306.3	1,379,000

[a] Number of working days in this week that fell in the year.
[b] Average daily production for the entire week, not for the working days that fell in the year.

WEEKLY PRODUCTION OF ANTHRACITE.

The working year in the anthracite region is somewhat less than the average for the bituminous-coal industry. The region is completely unionized, and union holidays are therefore observed by

practically all mines. In addition to Eight-hour Day (April 1) and Labor Day, the anthracite miners celebrate Mitchell Day (October 29) in memory of the ending of the famous strike of 1902. Other holidays not observed in the nonunion bituminous fields, such as Memorial Day, Thanksgiving, and Armistice Day, are now generally celebrated in the anthracite region. In consequence, the theoretical working year is 303 days for the anthracite mines, a figure that makes no allowance for church holy days, many of which are so generally observed as to decrease production seriously.

The statistics of weekly output of anthracite given in the following table are estimated from the records of cars of anthracite loaded by the nine railroads that serve the region. The weekly figures have been adjusted to the annual total ascertained by direct canvass from the operators themselves. The lowest output in a week during 1922 was 5,000 tons, in the last week of April, when the strike was at its height. This 5,000 tons consisted of steam sizes dredged from the rivers. A considerable part of the output of river coal comes from points outside the region itself, and some though not all of the dredge operators continued production during the strike. So far as is known to the Geological Survey, the production of deep mines ceased entirely.

After the settlement of the strike production was quickly resumed at a rate close to the recorded maximum, and in each of three weeks during the last quarter of the year the output passed 2,200,000 net tons. The highest mark for the year was 2,237,000 net tons, in the week ending December 16.

Estimated weekly production of anthracite in 1922, in net tons.

Week ending—	Production.	Number of working days.	Average production per working day.	Week ending—	Production.	Number of working days.	Average production per working day.
Jan. 7	1,264,000	5	253,000	July 15	32,000	6	5,000
14	1,673,000	6	279,000	22	28,000	6	5,000
21	1,469,000	6	245,000	29	27,000	6	5,000
28	1,636,000	6	273,000	Aug. 5	29,000	6	5,000
Feb. 4	1,844,000	6	307,000	12	40,000	6	7,000
11	1,855,000	6	309,000	19	38,000	6	6,000
18	1,734,000	6	289,000	26	37,000	6	6,000
25	1,732,000	6	289,000	Sept. 2	37,000	6	6,000
Mar. 4	1,947,000	6	325,000	9	51,000	5	10,000
11	2,018,000	6	336,000	16	1,127,000	6	188,000
18	1,941,000	6	324,000	23	1,897,000	6	316,000
25	2,133,000	6	356,000	30	1,982,000	6	330,000
Apr. 1	1,930,000	5	386,000	Oct. 7	1,994,000	6	332,000
8	9,000	6	2,000	14	2,112,000	6	352,000
15	6,000	6	1,000	21	2,039,000	6	340,000
22	6,000	6	1,000	28	1,836,000	6	306,000
29	5,000	6	1,000	Nov. 4	1,872,000	5	374,000
May 6	6,000	6	1,000	11	1,897,000	5	379,000
13	7,000	6	1,000	18	2,230,000	6	372,000
20	8,000	6	1,000	25	2,213,000	6	369,000
27	10,000	6	2,000	Dec. 2	1,852,000	5	370,000
June 3	8,000	5	2,000	9	2,075,000	6	346,000
10	13,000	6	2,000	16	2,237,000	6	373,000
17	22,000	6	4,000	23	2,065,000	6	344,000
24	24,000	6	4,000	30	1,588,000	5	318,000
July 1	25,000	6	4,000				
8	23,000	5	5,000		54,683,000	303	180,000

MONTHLY PRODUCTION BY STATES.

The following tables show the production of bituminous coal in each State for each month in 1921 and 1922. Corresponding data for the years 1917 to 1920 are to be found on pages 469–471 of Mineral Resources for 1921. The figures represent estimates based upon weekly reports of cars of coal and of beehive coke loaded by all the large coal-carrying roads, which were obtained either through the American Railway Association or directly from the carriers, and also upon monthly reports of coal shipped by waterways, which were courteously furnished by the United States Engineer Office.

The method of calculation is explained elsewhere.[4] The monthly estimates for each State are later revised to agree with the final statistics of total output for the year, which are obtained directly from the producers. The revised estimates are sufficiently accurate to show clearly the general trend of output in each State from season to season. For certain States, notably Illinois, Colorado, and Indiana, the records kept by State officials and local operators' associations have been utilized, wherever available, by adjusting them to agree with the final total production as ascertained by the Geological Survey.

[4] Tryon, F. G., Control statistics of coal production and distribution: Statistical Assoc. Quart. Pub., September, 1920, pp. 314–325.

Bituminous coal produced in the United States, by States and months, in 1922.

[Thousands of net tons.]

State.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Alabama	1,201	1,287	1,524	1,124	1,452	1,614	1,606	1,802	1,616	1,660	1,693	1,746	18,325
Arkansas	128	145	182	3	17	30	10	51	133	152	127	132	1,110
Colorado	811	789	988	403	600	776	763	959	852	928	1,008	1,143	10,020
Illinois	7,330	7,650	9,750	28	27	34	33	1,770	7,108	8,428	7,931	8,378	58,467
Indiana	2,373	2,634	3,309	8	16	13	20	364	2,166	2,598	2,628	3,004	19,133
Iowa	568	596	805					31	467	621	568	679	4,335
Kansas	284	326	450	31	52	100	78	158	347	411	335	383	2,955
Kentucky	2,896	3,215	3,608	3,171	5,335	5,482	3,296	3,627	2,662	2,876	2,937	3,029	42,134
Maryland	163	154	202	3	12	12	13	23	53	182	194	212	1,223
Michigan	119	109	139					28	126	154	119	135	929
Missouri	340	349	500	1	9	24	77	62	325	446	396	396	2,925
Montana	298	337	424	9	9	17	19	62	307	369	355	366	2,572
New Mexico	213	202	291	162	168	285	258	315	279	330	310	334	3,147
North Dakota	111	119	119	39	30	30	65	190	249	116	117	143	1,328
Ohio	2,658	2,871	3,534	270	366	354	351	1,632	3,980	3,614	3,761	3,563	26,954
Oklahoma	222	246	340	59	88	111	152	165	501	355	274	289	2,802
Pennsylvania	10,052	11,351	14,121	4,271	3,763	4,406	4,218	6,838	12,712	13,706	14,052	13,658	113,148
Tennessee	416	473	562	250	343	385	215	293	295	536	541	568	4,877
Texas	72	65	80	74	82	82	80	99	114	130	117	111	1,106
Utah	436	412	441	261	256	349	384	511	501	432	502	507	4,992
Virginia	685	778	893	805	1,087	1,125	1,086	751	738	850	837	856	10,491
Washington	299	299	341	83	83	83	103	134	262	300	284	310	2,581
West Virginia	6,529	7,229	8,411	5,269	7,199	7,769	4,751	6,745	5,948	6,668	6,881	7,089	80,488
Wyoming	710	775	906	1	1	1		123	682	841	897	1,035	5,972
Other States [a]	16	14	16	10	10	14	24	22	40	30	36	22	254
	38,930	42,425	51,936	16,335	21,005	23,096	17,602	26,755	42,463	46,733	46,900	48,088	422,268

[a] Includes Alaska, California, Georgia, Idaho, North Carolina, Oregon, and South Dakota.

PRODUCTION BY GROUPS OF STATES.

The next table shows the production of bituminous coal and lignite in 1920–1922 by groups of States. In 1921, as compared with 1920, every group suffered a loss. The decrease in quantity was heaviest in the group of Eastern States and in the group comprising Illinois, Indiana, and western Kentucky, but the loss in percentage was greatest in the groups comprising the Western and Southwestern States and in Tennessee. Though the coals from Pennsylvania, Maryland, and the Virginias are more widely distributed within the United States than any others, and though they practically monopolize the export trade from the Atlantic seaboard, the output of that group in 1921 declined 77,901,000 tons, or 28.2 per cent. Part of this loss, of course, was due to the relative inactivity in the steel and coke industries in 1921. To this relative inactivity and that in other industries was due also the decline of 22.1 per cent in eastern Kentucky, Ohio, and Michigan. Tennessee, which increased its output 27.8 per cent in 1920, lost 33 per cent in 1921; and Alabama, which also felt the depression in the iron and steel trade, saw its modest gain of 4.9 per cent in 1920 changed to a loss of 22.9 per cent in 1921. Illinois, Indiana, and western Kentucky were able to retain part of their increase of 42.8 per cent in 1920 over 1919, but the Dakotas, the Southwestern and Rocky Mountain States, and Washington fell not only behind their output in 1920 but behind that in 1919.

The controlling factor in determining group increases and decreases in 1922 was the general strike in the spring and summer. In Pennsylvania, Maryland, and the Virginias, a group comprising both union and nonunion districts, the increased activities in the nonunion territory were able to overcome the strike losses in the union territory. The group as a whole, therefore, showed a gain of 7,229,000 tons, or 3.6 per cent. In the group comprising eastern Kentucky, Michigan, and Ohio increased production from eastern Kentucky wiped out the strike losses in Ohio and Michigan and raised the group output 114,000 tons, or 0.2 per cent, over the total for 1921. Tennessee increased its output 417,000 tons, or 9.3 per cent. Alabama, hard hit in 1921 by the industrial depression, showed a gain of 5,756,000 tons, or 45.8 per cent. This recovery was the most pronounced of all. In percentage it far exceeded that for any other group. In tonnage the increase in this one State was only 1,473,000 tons, or 20.4 per cent, less than the increase in the group comprising Pennsylvania, Maryland, and the Virginias. The loss in the group comprising Illinois, Indiana, and western Kentucky, amounting to 7,091,000 tons, or 7.2 per cent, reflected strongly the strike losses in Illinois and Indiana. The effectiveness of union control is also revealed in the figures for the Dakota and Southwestern States group.

Bituminous coal and lignite produced in the United States, 1919–1922, by groups of States.[a]

	1919 (net tons).	1920			1921		
		Net tons.	Increase.		Net tons.	Decrease.	
			Net tons.	Percentage.		Net tons.	Percentage.
Pennsylvania, Maryland, West Virginia, and Virginia	242,143,000	276,022,000	33,879,000	13.9	198,121,000	77,901,000	28.2
Eastern Kentucky, Ohio, and Michigan	58,249,000	71,982,000	13,733,000	23.5	56,057,000	15,925,000	22.1
Tennessee	5,213,000	6,662,000	1,449,000	27.8	4,460,000	2,202,000	33.0
Alabama	15,537,000	16,294,000	757,000	4.9	12,569,000	3,725,000	22.9
Illinois, Indiana, and western Kentucky	90,435,000	129,152,000	38,717,000	42.8	98,538,000	30,614,000	23.7
North Dakota, South Dakota, Iowa, Missouri, Kansas, Oklahoma, Arkansas, and Texas	22,596,000	28,639,000	6,043,000	26.7	17,985,000	10,654,000	37.2
Colorado, Montana, Wyoming, Utah, and New Mexico	28,550,000	36,011,000	7,461,000	26.1	25,590,000	10,421,000	28.9
Washington	2,990,000	3,757,000	767,000	25.6	2,429,000	1,328,000	35.3

	1922		
	Net tons.	Increase or decrease.	
		Net tons.	Percentage.
Pennsylvania, Maryland, West Virginia, and Virginia	205,350,000	+7,229,000	+3.6
Eastern Kentucky, Ohio, and Michigan	56,171,000	+114,000	+.2
Tennessee	4,877,000	+417,000	+9.3
Alabama	18,325,000	+5,756,000	+45.8
Illinois, Indiana, and western Kentucky	91,447,000	−7,091,000	−7.2
North Dakota, South Dakota, Iowa, Missouri, Kansas, Oklahoma, Arkansas, and Texas	16,569,000	−1,416,000	−7.9
Colorado, Montana, Wyoming, Utah, and New Mexico	26,703,000	+1,113,000	+4.3
Washington	2,581,000	+152,000	+6.3

[a] Does not include production in Alaska, California, Georgia, Idaho, North Carolina, and Oregon.

SUMMARY TABLES OF PRODUCTION BY STATES.

The production by States in 1921 and 1922 is shown in the tables on pages 477–478, which are discussed farther on in this report. The first column in these tables shows the quantity of coal loaded at the mines on railroad cars or on boats for shipment. The figures given represent all coal shipped, regardless of distance. Considerable coal mined near Birmingham, Ala., and near Pittsburgh, Pa., is used by the iron and steel industries of those cities, but as this coal is actually loaded on cars or boats it is reported as "loaded at the mines for shipment." Coal used for making coke, if actually loaded, is similarly reported, even if it has to be shipped less than a mile. All coal used as railroad fuel, except that loaded directly into engine tenders at the mines, is also so reported. The question whether such coal is revenue or nonrevenue freight does not enter into the classification.

The second column of the tables shows coal "sold to local trade and used by employees." This designation includes wagon business, coal used by employees, coal loaded into engine tenders for railroad consumption, and coal used in the immediate vicinity of the mines by brick and sewer-pipe plants, power plants, and mills of different kinds. This coal is presumably carried from the mine to the place of consumption in mine cars, wagons, or trucks, or on private tramroads.

The coal used to generate steam and heat for the operation of the mines is shown in the third column, and that charged into coke ovens at the mines in the fourth column.

The "total quantity" reported in the fifth column is the sum of the figures shown in the four preceding columns and represents only usable fuel. Refuse, slate, bone brought out of the mine or picked and sorted from the coal in the tipple, and refuse from washeries and dry-cleaning plants are not considered part of the coal produced, although the cost per ton of bringing this material to the surface is as great as that of the usable fuel.

The "total value" is the sum of all the values reported by the individual operators, and the "average value per ton" is that total divided by the total number of tons.

Coal produced in the United States in 1921 and 1922.

[Exclusive of product of wagon mines.]

State.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Tota. value.	Average value per ton.	Number of employees.				Average number of days worked.
								Underground.		Surface.	Total.	
								Miners, loaders, etc.[a]	All others.			
1921.												
Alabama	11,834,609	313,125	292,807	128,358	12,568,899	$38,713,000	$3.08	15,304	5,869	4,636	25,809	166
Alaska	71,999	3,005	1,813		76,817	496,000	6.46	104	79	218	401	244
Arkansas	1,174,584	19,477	33,716		1,227,777	5,360,000	4.37	2,315	848	453	3,616	112
California, Idaho, and Oregon	19,015	13,305	6,525		38,845	181,000	4.66	35	48	58	141	149
Colorado	8,408,613	399,816	253,718	60,613	9,122,760	32,377,000	3.55	8,456	3,450	2,623	14,529	164
Georgia	18,755	373	1,979	12,708	33,815	171,000	2.14	59	26	51	136	183
Illinois	64,174,112	3,371,482	2,057,169		69,602,763	190,986,000	2.74	60,466	25,043	9,922	95,431	152
Indiana	19,116,259	610,620	592,630		20,319,509	52,269,000	2.57	20,472	8,460	3,755	32,687	128
Iowa	3,891,368	521,465	118,559		4,531,392	17,256,800	3.81	7,597	2,815	974	11,386	148
Kansas	3,250,299	111,448	104,894		3,466,641	13,333,300	3.85	5,453	1,538	1,216	8,207	137
Kentucky	30,096,762	802,744	527,257	161,507	31,588,270	85,092,600	2.69	28,737	12,996	8,788	50,521	152
Maryland	1,743,710	56,734	27,296		1,827,740	6,602,000	3.61	2,964	978	726	4,668	120
Michigan	1,058,789	11,354	71,572		1,141,715	5,555,000	4.87	1,346	622	244	2,212	196
Missouri	3,209,496	242,136	99,989		3,551,621	13,915,500	3.92	5,141	1,830	1,584	8,555	166
Montana	2,492,344	115,538	126,076		2,733,958	8,921,600	3.26	2,396	1,064	718	4,178	143
New Mexico	2,326,034	34,754	62,259	30,435	2,453,482	9,585,000	3.91	2,735	1,120	722	4,577	150
North Carolina	20,000		3,438		23,438	135,000	5.76	38	7	15	60	300
North Dakota	700,950	135,550	28,403		864,903	2,329,500	2.69	566	209	289	1,064	194
Ohio	29,788,393	1,559,953	594,243	187	31,942,776	84,686,500	2.65	33,143	11,555	7,087	51,785	134
Oklahoma	3,208,381	25,559	128,683		3,362,623	15,546,000	4.62	5,000	2,425	1,429	8,854	141
Pennsylvania (bituminous)	102,025,340	4,315,590	2,552,372	7,120,640	116,013,942	322,538,300	2.78	119,818	44,404	26,421	190,643	151
South Dakota	450	7,069	34		7,553	21,200	2.81	43			43	129
Tennessee	4,194,364	88,199	123,730	54,033	4,460,326	14,932,000	3.35	6,061	2,500	1,786	10,347	154
Texas	947,589	2,691	22,559		972,839	2,563,600	2.64	1,989	609	294	2,892	139
Utah	3,668,661	74,705	73,365	262,053	4,078,784	13,662,000	3.35	2,450	1,041	931	4,422	151
Virginia	6,818,178	152,729	98,950	422,521	7,492,378	22,947,700	3.06	5,751	4,056	2,115	11,922	166
Washington	2,274,262	59,644	88,585	6,291	2,428,722	9,787,000	4.03	2,241	1,245	848	4,334	159
West Virginia	68,655,196	2,983,061	808,609	340,130	72,786,996	206,661,500	2.84	53,801	30,951	17,098	101,850	149
Wyoming	6,875,284	103,495	221,887		7,200,666	23,358,500	3.24	4,789	2,231	1,464	8,484	167
Total bituminous	382,063,736	16,135,621	9,123,117	8,599,476	415,921,950	1,199,983,600	2.89	399,270	168,019	96,465	663,754	149
Pennsylvania (anthracite)	77,901,110	2,812,551	9,759,790		90,473,451	452,305,000	5.00	73,977	42,840	42,682	159,499	271
Grand total	459,964,846	18,948,172	18,882,907	8,599,476	506,395,401	1,652,288,600	3.26	473,247	210,859	139,147	823,253	173

[a] Includes also shot firers.

Coal produced in the United States in 1921 and 1922—Continued.

State.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.				Average number of days worked.
								Underground.		Surface.	Total.	
								Miners, loaders, etc.[a]	All others.			
1922.												
Alabama	17,376,060	360,811	290,187	297,682	18,324,740	$42,856,000	$2.34	16,615	6,528	5,026	28,169	215
Alaska	76,111	1,221	1,943	----------	79,275	431,000	5.43	149	113	168	430	147
Arkansas	1,066,751	15,112	28,183	----------	1,110,046	4,592,000	4.14	2,386	973	676	4,035	81
California, Idaho, and Oregon	17,011	3,662	6,220	----------	26,893	104,000	3.87	20	25	15	60	250
Colorado	9,144,680	542,783	232,255	99,879	10,019,597	31,701,000	3.16	7,911	3,158	2,437	13,506	191
Georgia	41,809	535	2,114	16,178	60,636	246,000	4.06	68	23	59	150	242
Illinois	53,695,042	3,227,015	1,545,679	----------	58,467,736	168,925,000	2.89	61,592	24,704	10,040	96,336	120
Indiana	18,142,677	537,310	452,902	----------	19,132,889	54,524,000	2.85	20,605	8,288	4,315	33,208	110
Iowa	3,653,352	579,907	101,902	----------	4,335,161	16,119,000	3.72	8,369	3,477	1,011	12,857	131
Kansas	2,797,291	96,831	61,048	----------	2,955,170	10,816,000	3.66	5,093	1,319	947	7,359	125
Kentucky	40,554,793	991,145	534,578	53,659	42,134,175	127,037,000	3.02	34,189	16,207	10,528	60,924	140
Maryland	1,165,738	44,676	12,293	----------	1,222,707	4,122,000	3.37	2,563	663	529	3,755	101
Michigan	855,917	13,814	59,659	----------	929,390	4,693,000	5.05	1,335	639	192	2,166	162
Missouri	2,620,074	228,327	76,349	----------	2,924,750	11,153,000	3.81	5,370	1,848	1,532	8,750	113
Montana	2,395,091	92,413	84,717	----------	2,572,221	8,208,500	3.19	2,194	904	537	3,635	140
New Mexico	2,871,424	35,931	57,479	182,339	3,147,173	10,977,000	3.49	2,253	969	779	4,001	216
North Carolina	68,524	1,500	8,546	----------	78,570	388,000	4.94	50	45	32	127	167
North Dakota	1,078,139	211,193	38,232	----------	1,327,564	3,513,000	2.65	846	290	512	1,648	175
Ohio	24,434,491	1,953,222	566,078	----------	26,953,791	87,056,000	3.23	34,134	11,772	8,288	54,194	160
Oklahoma	2,627,406	28,381	146,724	----------	2,802,511	11,527,000	4.11	4,390	2,234	1,204	7,828	114
Pennsylvania (bituminous)	94,939,698	5,130,548	2,214,591	10,863,471	113,148,308	351,777,000	3.11	114,541	44,910	29,387	188,838	154
South Dakota	450	7,302	----------	----------	7,752	22,000	2.84	32	----------	----------	32	138
Tennessee	4,546,552	111,977	113,854	104,391	4,876,774	14,096,000	2.89	6,996	2,537	1,916	11,449	163
Texas	1,076,595	12,557	16,855	----------	1,106,007	2,563,000	2.32	1,994	541	306	2,841	185
Utah	4,530,382	61,930	99,282	300,414	4,992,008	15,687,500	3.14	2,302	1,327	1,092	4,721	204
Virginia	9,650,588	156,354	100,020	584,212	10,491,174	27,083,000	2.58	6,290	4,567	2,542	13,399	198
Washington	2,392,305	63,135	84,700	41,025	2,581,165	10,279,000	3.98	2,434	1,170	877	4,481	194
West Virginia	76,150,385	2,918,643	709,139	710,025	80,488,192	236,162,000	2.93	57,785	33,029	19,200	110,014	143
Wyoming	5,708,071	77,914	185,739	----------	5,971,724	18,162,000	3.04	5,266	2,377	1,402	9,045	128
Total bituminous, including wagon mines	383,677,407	17,506,149	7,831,268	13,253,275	422,268,099	1,274,820,000	3.02	407,772	174,637	105,549	687,958	142
Pennsylvania (anthracite)	46,002,699	2,378,200	6,302,123	----------	54,683,022	273,700,000	5.01	72,527	41,752	42,570	156,849	151
Grand total	429,680,106	19,884,349	14,133,391	13,253,275	476,951,121	1,548,520,000	3.25	480,299	216,389	148,119	844,807	144

[a] Includes also shot firers.

Under ordinary conditions the production of bituminous coal is responsive alike to broad movements in industrial and domestic demand and to slight changes within small areas. The prolonged strike in 1922, however, not only subordinated demand in general to the limitations placed upon production by the suspensions in most of the organized bituminous-coal districts but reduced the figures of production for the individual States to the status of minor reflections of the effect of the major disturbance. The changes in output and value in 1922 as compared with 1921, shown in the table on page 481, should be examined in the light of that fact. Because certain of the major producing States, notably Pennsylvania and West Virginia, embrace both union and nonunion districts and because some semiorganized areas were less affected than others, a study based solely on the next table would be incomplete and misleading. To get a comprehensive picture of the situation it is necessary to examine also the statistics for the individual States given later on and the detailed analysis of the strike beginning on page 512.

The fact that the total production of bituminous coal in 1922 showed a small gain over that of the preceding year despite the strike emphasized the depth of the 1921 depression, but the total output for the year illustrated with equal force the great reserve capacity of the bituminous mines. This reserve capacity—the "overdevelopment" so much discussed in recent years—enabled union mines to speed up production before and nonunion mines during the strike. This speeding process in the districts not affected by the strike piled up increases in output that offset the losses in the union strike-bound districts. The contrast between reserve mine capacity in the anthracite and bituminous fields, as illustrated by the records for that year, is striking. In the former neither physical capacity nor labor supply was adequate to make up the strike losses by poststrike activity.

Kentucky's output in 1922 showed the largest increase in tonnage over 1921. The increase was 10,545,905 tons, or 33.4 per cent, as compared with an increase for the country of only 6,346,149 tons, or 1.5 per cent. West Virginia came second, with a gain of 7,701,196 tons, or 10.6 per cent. The burden of supplying the East and the central competitive field territory during the strike fell largely upon three States—Pennsylvania, West Virginia, and Kentucky—although other nonaffected districts in the Appalachian region also contributed. Unlike West Virginia, however, Pennsylvania found that the losses in the organized districts offset gains in the nonunion field, so that the State as a whole showed a loss of 2,865,634 tons, or 2.5 per cent, when compared with 1921. Alabama ranked third in tonnage gains and first among the larger producing States in percentage gains—the figures being 5,755,841 tons, or 45.8 per cent. Production in Virginia increased 2,998,796 tons, or 40 per cent. North Carolina, with an increase of 235.2 per cent, and Georgia, with an increase of 79.3 per cent, led in percentage increase, but in neither State was the gain in tonnage large. North Dakota came third in percentage increase, with a gain of 53.5 per cent, and her increase in quantity was 462,661 tons, as compared with an increase of only 199 tons, or 2.6 per cent, in South Dakota. Although one-third of the miners in North Dakota joined the strike, the shortage of coal from other States had a most favorable effect upon the total output for the

year. Increases were also registered by all the far Western States, except Colorado, Montana, and Wyoming.

Illinois, with a decrease of 11,135,027 tons, was the hardest hit in tonnage. Maryland suffered the greatest percentage loss—33.1 per cent—although the decrease in output was only 605,033 tons. Ohio ranked second in tonnage loss, her production falling off 4,988,985 tons. Barring a few local operations and the ill-fated stripping ventures near Herrin, Ill., and New Lexington, Ohio, production was at a standstill in Illinois and Ohio during the period of the strike. Indiana, where the situation was similar to that in the two States just named, escaped with a much smaller loss—1,186,620 tons, or 5.8 per cent, as compared with declines of 16 per cent in Illinois and 15.6 per cent in Ohio.

The decrease in the value of the coal produced in Illinois in 1922 as compared with 1921—$22,061,000—was not only the greatest reported among all the States, but was the only decrease reported in a State in the central competitive field. Indiana, mining 1,186,620 tons less in 1922 than in 1921, showed an increase in aggregate value of $2,255,000, or 4.3 per cent. Ohio lost 4,988,985 tons in quantity but gained $2,369,500, or 2.8 per cent, in value. Pennsylvania bituminous coal declined 2,865,634 tons, but the value of the coal produced increased $29,238,700, or 9.1 per cent. This increase closely approximated that reported for West Virginia, in which there was also an increase in tonnage. The greatest increase in value was made in Kentucky, where the gain was $41,944,400, or 49.3 per cent, as compared with a tonnage increase of 33.4 per cent. Kentucky, South Dakota, and West Virginia were the only States reporting increases in tonnage in which the percentage gain in value exceeded the percentage gain in quantity. In Colorado, Tennessee, and Texas the quantity produced in 1922 was greater than that produced in 1921, but the aggregate value was less.

The quantity and value of the coal produced in each State in 1921 and 1922 and the increase or decrease in quantity and in percentage in 1922 as compared with 1921 are shown in the following table. The annual production of coal in each State from the time of the earliest recorded output until the end of 1922 is given in the tabular statement in the pocket. (See also fig. 16.)

Coal produced in the United States, 1921–22, and increase or decrease in 1922.

State.	1919		1920		1921 [a]		1922		Increase or decrease, 1922.			
									Quantity.		Value.	
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Per-cent-age.	Dollars.	Per-cent-age.
Alabama	15,536,721	$45,937,681	16,294,099	$59,410,000	12,568,899	$38,713,000	18,324,740	$42,856,000	+5,755,841	+45.8	+4,143,000	+10.7
Arkansas	1,429,020	5,288,844	2,103,596	9,592,000	1,227,777	5,360,000	1,110,046	4,592,000	−117,731	−9.6	−768,000	−14.3
California, Alaska, and Idaho	67,228	365,721	[b] 84,581	[b] 461,000	[b] 115,662	[b] 677,000	[b] 106,168	[b] 535,000	− [b] 9,494	−8.2	− [b] 142,000	−21.0
Colorado	10,323,420	28,748,534	12,278,225	42,829,000	9,122,760	32,377,000	10,019,597	31,701,000	+896,837	+9.8	−676,000	−2.1
Georgia	53,337	198,033	50,156	251,000	33,815	171,000	60,636	246,000	+26,821	+79.3	+75,000	+43.9
Illinois	60,862,608	140,075,969	88,724,893	273,509,000	69,602,763	190,986,000	58,467,736	168,925,000	−11,135,027	−16.0	−22,061,000	−11.6
Indiana	20,912,288	46,345,750	29,350,585	92,867,000	20,319,509	52,269,000	19,132,889	54,524,000	−1,186,620	−5.8	+2,255,000	+4.3
Iowa	5,624,692	17,352,620	7,813,916	30,794,000	4,531,392	17,256,800	4,335,161	16,119,000	−196,231	−4.3	−1,137,800	−6.6
Kansas	5,224,724	15,917,053	5,926,408	22,923,000	3,466,641	13,333,300	2,955,170	10,816,000	−511,471	−14.8	−2,517,300	−18.9
Kentucky	30,036,061	73,891,049	35,690,762	146,576,000	31,588,270	85,092,600	42,134,175	127,037,000	+10,545,905	+33.4	+41,944,400	+49.2
Maryland	3,021,686	8,255,984	4,065,239	18,815,000	1,827,740	6,602,000	1,222,707	4,122,000	−605,033	−33.1	−2,480,000	−37.6
Michigan	996,545	3,864,228	1,489,765	7,346,000	1,141,715	5,555,000	929,390	4,693,000	−212,325	−18.6	−862,000	−15.5
Missouri	3,979,798	12,766,366	5,369,565	22,230,000	3,551,621	13,915,500	2,924,750	11,153,000	−626,871	−17.7	−2,762,500	−9.2
Montana	3,236,369	8,644,344	4,413,866	13,923,000	2,733,958	8,921,600	2,572,221	8,208,500	−161,737	−5.9	−713,100	−8.0
New Mexico	3,138,756	9,750,833	3,683,440	13,568,000	2,453,482	9,585,000	3,147,173	10,977,000	+693,691	+28.3	+1,392,000	+14.5
North Carolina	6,989	26,871	11,540	81,000	23,438	135,000	78,570	388,000	+55,132	+235.2	+253,000	+187.4
North Dakota	840,959	2,100,303	948,625	2,724,000	864,903	2,329,500	1,327,564	3,513,000	+462,661	+53.5	+1,183,500	+50.8
Ohio	35,876,682	79,496,301	45,878,191	175,081,000	31,942,776	84,686,500	26,953,791	87,056,000	−4,988,985	−15.6	+2,369,500	+2.8
Oklahoma	3,802,113	14,544,901	4,849,288	23,294,000	3,362,623	15,546,000	2,802,511	11,527,000	−560,112	−16.7	−4,019,000	−25.9
Oregon	18,739	63,794	[b]	[b]	[b]	[b]	[b]	[b]	[b]		[b]	
Pennsylvania (bituminous)	150,758,154	365,430,504	170,607,847	642,630,000	116,013,942	322,538,300	113,148,308	351,777,000	−2,865,634	−2.5	+29,238,700	+9.1
South Dakota	14,417	45,707	12,777	46,000	7,553	21,200	7,752	22,000	+199	+2.6	+800	+3.8
Tennessee	5,213,205	14,448,168	6,662,428	26,778,000	4,460,326	14,932,000	4,876,774	14,096,000	+416,448	+9.3	−836,000	−5.6
Texas	1,680,656	4,527,640	1,615,015	6,062,000	972,839	2,563,600	1,106,007	2,563,000	+133,168	+13.7	−600	−0.0
Utah	4,631,323	12,760,613	6,005,199	19,350,000	4,078,784	13,662,000	4,992,008	15,687,500	+913,224	+22.4	+2,025,500	+14.8
Virginia	9,326,830	23,774,941	11,378,606	45,446,000	7,492,378	22,947,700	10,491,174	27,083,000	+2,998,796	+40.0	+4,135,300	+18.0
Washington	2,990,447	10,691,222	3,757,093	14,560,000	2,428,722	9,787,000	2,581,165	10,279,000	+152,443	+6.3	+492,000	+5.0
West Virginia	79,036,553	196,551,015	89,970,707	390,046,000	72,786,996	206,661,500	80,488,192	236,162,000	+7,701,196	+10.6	+29,500,500	+14.3
Wyoming	7,219,738	18,751,024	9,630,271	28,741,000	7,200,666	23,358,500	5,971,724	18,162,000	−1,228,942	−17.1	−5,196,500	−22.3
Total bituminous	465,860,058	1,160,616,013	568,666,683	2,129,933,000	415,921,950	1,199,983,600	422,268,099	1,274,820,000	+6,346,149	+1.5	+74,836,400	+6.2
Pennsylvania anthracite	88,092,201	364,926,950	89,598,249	434,252,000	90,473,451	452,305,000	54,683,022	273,700,000	−35,790,429	−39.6	−178,605,000	−39.5
Grand total	553,952,259	1,525,542,963	658,264,932	2,564,185,000	506,395,401	1,652,288,600	476,951,121	1,548,520,000	−29,444,280	−5.8	−103,768,600	−6.3

[a] Exclusive of wagon mines.

[b] California includes Oregon.

GROWTH OF ANNUAL PRODUCTION.

At the beginning of the twentieth century the annual output of bituminous coal was approximately 200,000,000 tons. To-day it has increased to 550,000,000 tons in a year of active business. Up to about 1918 its growth was fairly steady and has been computed by Prof. E. E. Day, of the Harvard Committee on Economic Research, to be at the rate of 16,800,000 tons a year. The fluctuations in output above and below the line of normal growth, as determined by Day, are shown in Figure 19. They represent largely the ebb and flow of coal consumption following the activity of general business. In boom times the country has consumed greatly increased amounts

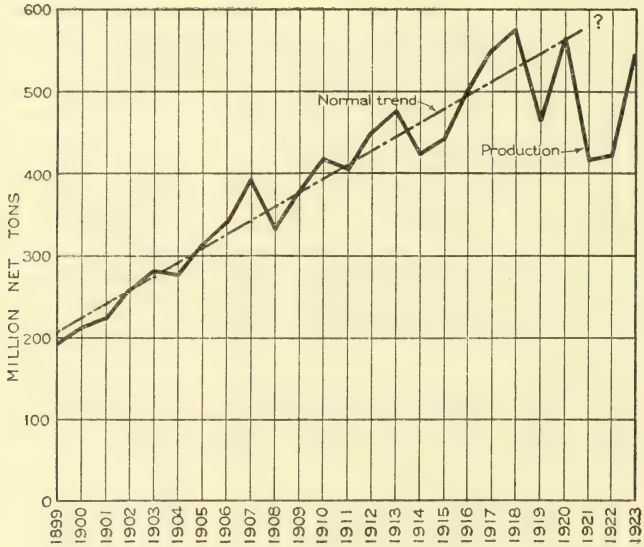


FIGURE 19.—Annual production of bituminous coal and line of normal trend, 1899–1922, as computed by E. E. Day. The normal growth of production from 1899 to 1919 was computed by Professor Day to be at the rate of 16,809,000 tons a year. Since 1919 this rate of increase has not been maintained, chiefly because of the great depression of 1921 and the strike of 1922, but also apparently because the slope of the line of normal growth is changing.

of coal, and the line of output has risen above normal. Such a condition occurred in 1907, when the actual output was 115 per cent of the calculated normal, and again in the good times immediately preceding the European war and in the period of extreme activity from 1916 to 1918 induced by the war itself. In like manner, when business has been dull and the demand for coal curtailed, as in 1904, 1908, and 1914–15, the line of output has fallen below the calculated normal. It is noteworthy that the percentage departure from the normal as thus computed for bituminous coal agrees closely with percentages similarly computed for pig iron and for all manufacturing business.

Since the war, however, no such rate of increase in output has been maintained. The downward jog of 1919 was of course caused by the great strike of that year, but the recovery in 1920, when consumers bought heavily to rebuild their depleted stocks, was barely sufficient to bring the output up to the calculated normal. In the

great depression of 1921 production dropped to 71 per cent of the computed normal, and in 1922 it was no better.

It seems clear that the annual rate of increase of the pre-war period can no longer be accepted as the measure of the normal production of soft coal. Various factors have combined to bring about a slowing up of the former rate of increase. They include economies in the utilization of coal resulting from the high prices of the last seven years; competition of water and, more important, of fuel oil; and also apparently a reduction of the rate of increase in the country's requirements for fuel and power. It is too early yet to measure the normal rate of increase under present conditions. All that can now be said is that, measured by former standards, production during the years 1919 to 1923 has failed to keep pace with what might have been expected.

Normal production of bituminous coal as calculated by Day and percentage of normal produced, 1899 to 1923.

Year.	Calculated normal (tons).	Percentage of normal produced.	Year.	Calculated normal (tons).	Percentage of normal produced.
1899	208,000,000	93	1913	446,000,000	108
1900	225,000,000	94	1914	463,000,000	92
1901	242,000,000	93	1915	480,000,000	92
1902	259,000,000	100	1916	497,000,000	101
1903	276,000,000	102	1917	513,000,000	108
1904	293,000,000	95	1918	530,000,000	109
1905	309,000,000	102	1919	547,000,000	85
1906	326,000,000	105	1920	564,000,000	101
1907	343,000,000	115	1921	581,000,000	71
1908	360,000,000	92	1922	598,000,000	71
1909	377,000,000	101	1923	614,000,000	89
1910	394,000,000	106	1924	631,000,000	----------
1911	410,000,000	99	1925	648,000,000	----------
1912	429,000,000	105			

Coal produced in the United States from 1807 to 1922, inclusive, in net tons.

Year.	Pennsylvania anthracite.	Bituminous.	Total.	Year.	Pennsylvania anthracite.	Bituminous.	Total.
1807–1820	12,000	3,000	15,000	1846	2,887,815	1,977,707	4,865,522
				1847	3,551,005	1,735,062	5,286,067
1821	1,322	----------	1,322	1848	3,805,942	1,968,032	5,773,974
1822	4,583	54,000	58,583	1849	3,995,334	2,453,497	6,448,831
1823	8,563	60,000	68,563	1850	4,138,164	2,880,017	7,018,181
1824	13,685	67,040	80,725				
1825	42,988	75,000	117,988	1851	5,481,065	3,253,460	8,734,525
				1852	6,151,957	3,664,707	9,816,664
1826	59,194	88,720	147,914	1853	6,400,426	4,169,862	10,570,288
1827	78,151	94,000	172,151	1854	7,394,875	4,582,227	11,977,102
1828	95,500	100,408	195,908	1855	8,141,754	4,784,919	12,926,673
1829	138,086	102,000	240,086				
1830	215,272	104,800	320,072	1856	8,534,779	5,012,146	13,546,925
				1857	8,186,567	5,153,622	13,340,189
1831	217,842	120,100	337,942	1858	8,426,102	5,548,376	13,974,478
1832	447,550	146,500	594,050	1859	9,619,771	6,013,404	15,633,175
1833	600,907	133,750	734,657	1860	8,115,842	6,494,200	14,610,042
1834	464,015	136,500	600,515				
1835	690,854	134,000	824,854	1861	9,799,654	6,688,358	16,488,012
				1862	9,695,110	7,790,725	17,485,835
1836	842,832	142,000	984,832	1863	11,785,320	9,533,742	21,319,062
1837	1,071,151	182,500	1,253,651	1864	12,538,649	11,066,474	23,605,123
1838	910,075	445,452	1,355,527	1865	11,891,746	11,900,427	23,792,173
1839	1,008,322	552,038	1,560,360				
1840	967,108	1,102,931	2,070,039	1866	15,651,183	13,352,400	29,003,583
				1867	16,002,109	14,722,313	30,724,422
1841	1,182,441	1,108,700	2,291,141	1868	17,003,405	15,858,555	32,861,960
1842	1,365,563	1,244,494	2,610,057	1869	17,083,134	15,821,226	32,904,360
1843	1,556,753	1,504,121	3,060,874	1870	15,664,275	17,371,305	33,035,580
1844	2,009,207	1,672,045	3,681,252				
1845	2,480,032	1,829,872	4,309,904				

Coal produced in the United States from 1807 to 1922, inclusive, in net tons—Con.

Year.	Pennsylvania anthracite.	Bituminous.	Total.	Year.	Pennsylvania anthracite.	Bituminous.	Total.
1871	19, 342, 057	27, 543, 023	46, 885, 080	1897	52, 611, 680	147, 617, 519	200, 229, 199
1872	24, 233, 166	27, 220, 233	51, 453, 399	1898	53, 382, 644	166, 593, 623	219, 976, 267
1873	26, 152, 837	31, 449, 643	57, 602, 480	1899	60, 418, 005	193, 323, 187	253, 741, 192
1874	24, 818, 790	27, 787, 130	52, 605, 920	1900	57, 367, 915	212, 316, 112	269, 684, 027
1875	22, 485, 766	29, 862, 554	52, 348, 320	1901	67, 471, 667	225, 828, 149	293, 299, 816
				1902	41, 373, 595	260, 216, 844	301, 590, 439
1876	22, 793, 245	30, 486, 755	53, 280, 000	1903	74, 607, 068	282, 749, 348	357, 356, 416
1877	25, 660, 316	34, 841, 444	60, 501, 760	1904	73, 156, 709	278, 659, 689	351, 816, 398
1878	21, 689, 682	36, 245, 918	57, 935, 600	1905	77, 659, 850	315, 062, 785	392, 722, 635
1879	30, 207, 793	37, 898, 006	68, 105, 799	1906	71, 282, 411	342, 874, 867	414, 157, 278
1880	28, 649, 812	42, 831, 758	71, 481, 570	1907	85, 604, 312	394, 759, 112	480, 363, 424
				1908	83, 268, 754	332, 573, 944	415, 842, 698
1881	31, 920, 018	53, 961, 012	85, 881, 030				
1882	35, 121, 256	68, 429, 933	103, 551, 189	1909	81, 070, 359	379, 744, 257	460, 814, 616
1883	38, 456, 845	77, 250, 680	115, 707, 525	1910	84, 485, 236	417, 111, 142	501, 596, 378
1884	37, 156, 847	82, 998, 704	120, 155, 551	1911	90, 464, 067	405, 907, 059	496, 371, 126
1885	38, 335, 974	72, 824, 321	111, 160, 295	1912	84, 361, 598	450, 104, 982	534, 466, 580
				1913	91, 524, 922	478, 435, 297	569, 960, 219
1886	39, 035, 446	74, 644, 981	113, 680, 427	1914	90, 821, 507	422, 703, 970	513, 525, 477
1887	42, 088, 197	88, 562, 314	130, 650, 511	1915	88, 995, 061	442, 624, 426	531, 619, 487
1888	46, 619, 564	102, 040, 093	148, 659, 657	1916	87, 578, 493	502, 519, 682	590, 098, 175
1889	45, 546, 970	95, 682, 543	141, 229, 513	1917	99, 611, 811	551, 790, 563	651, 402, 374
1890	46, 468, 641	111, 302, 322	157, 770, 963	1918	98, 826, 084	579, 385, 820	678, 211, 904
				1919	88, 092, 201	465, 860, 058	553, 952, 259
1891	50, 665, 431	117, 901, 238	168, 566, 669	1920	89, 598, 249	568, 666, 683	658, 264, 932
1892	52, 472, 504	126, 856, 567	179, 329, 071				
1893	53, 967, 543	128, 385, 231	182, 352, 774	1921	90, 473, 451	415, 921, 950	506, 395, 401
1894	51, 921, 121	118, 820, 405	170, 741, 526	1922	54, 683, 022	422, 268, 099	476, 951, 121
1895	57, 999, 337	135, 118, 193	193, 117, 530				
1896	54, 346, 081	137, 640, 276	191, 986, 357		3,235,375,889	11,769,205,178	15, 004, 581, 067

Figure 20 compares the growth of production with that of mine capacity and numbers employed. The average receipts from sales and the number of days lost annually through nonoperation of the mine are also shown.

STATISTICS OF LABOR.

METHOD OF COLLECTING STATISTICS.

The annual schedules upon which coal-mine operators report to the Geological Survey contain an inquiry as to the average number of men employed during the year, exclusive of coke workers and office force, classified as underground and surface employees. The number of days of operation for a given mine may be determined easily from the mine records. To determine accurately the average number of men employed in the year is more difficult, and no general instructions as to the method to be used in calculating the average have been issued by the Geological Survey.

The ideal method, where the records available permit its use, is to ascertain the total number of shifts or man-days of labor during the year and divide this number by the number of days the mine worked. The number of man-days of day workers—that is, men paid by the day—can be ascertained from the pay roll, but to get the man-days of the tonnage workers—the men paid by the piece—would require special records, which are not kept by most bituminous operators at the present time. At few mines is a record kept of hours spent underground by the tonnage men—in fact, at the majority of mines the only evidence that a pick miner or loader had worked

at all on a given day would be the presence or absence of his check number on the weigh sheets. The lack of such a record of the time worked by tonnage men impairs the value of practically all studies of the coal industry involving wages, earnings, employment, accident rates, and the efficiency of both management and labor.

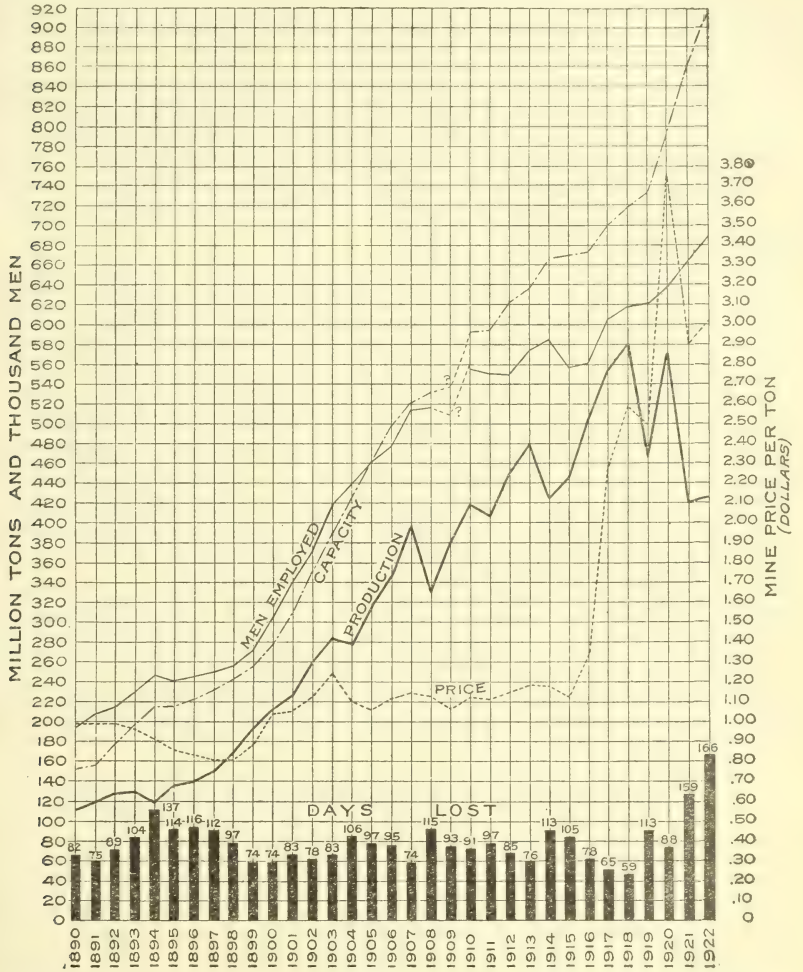


FIGURE 20.—Production, capacity, men employed, mine price per ton, and average number of days lost at bituminous-coal mines, 1890–1922.

Another method, which is followed by many operators in reporting to the Survey, is to calculate the average number of men on each of the pay rolls during the year. This method inflates the statistics to the extent that the same employees appear on the pay rolls of two or more operations in the same period—that is, duplication is introduced in proportion to the rapidity of labor turnover. This turnover is a factor of no small importance in studies purely of labor and efficiency. The United States Coal Commission's anthracite investigation, for

example, disclosed a turnover of 55 to 115 per cent in the hard-coal region. Collateral evidence indicates, however, that the inflation due to this cause is not large enough to impair the figures seriously. At a mine that worked steadily during the year the average of the 24 semimonthly pay rolls would give a fairly accurate measure of the number employed, but of course many mines do not work steadily. A strike that lasted through an entire pay period would cut the number drawing pay for that period to a small fraction of the normal working force, ordinarily to the engineers, firemen, and pump men. To include a pay roll for such a period in calculating the average number employed would be misleading, and the returns clearly show that the operators do not include pay rolls of this kind. Neither do they include pay periods when the mine is idle the entire time through lack of demand. Probably many small operators do not even average the pay rolls for the year, but rather set down the number shown by the last pay roll.

Careful study of the returns under the diverse conditions of the last four years—the strike years, 1919 and 1922; the boom year, 1920; and the year of depression, 1921—indicates that the figures reported are not the average number of men actually working at any one time, nor the aggregate number of men who have worked at the mine during the year, nor the absolute average number of men on the pay rolls, but rather the number of men commonly dependent on the mine for employment. They represent the number ordinarily reporting for work when the mine starts plus the absentees, the men who have been working recently and who will work again but who for one reason or another are not on hand. The totals for districts and the United States are therefore a fair measure of the total number of coal-mine workers.

These statistics have their limitations. They are not accurate in all details, but they are comparable from year to year for each unit of the industry and represent the most accurate returns obtainable under present conditions, both as to records generally available at mine offices and as to the funds allotted to the Geological Survey for their collection.

MEN EMPLOYED IN THE ANTHRACITE COLLIERIES.

The supply of labor available for the production of Pennsylvania anthracite in 1922 declined to 156,849 men. The total was 2,650 less than during the preceding year, but, with that exception, the number reported was the largest since 1916. Since 1914, when the peak figure of 179,679 men was reached, there has been a notable decrease in the number of men reporting for work at the hard-coal collieries. Between 1914 and 1918 the total declined to 147,121 men, a loss of 18 per cent. There was a slight increase in the total in 1919, but the total for 1920—145,074 men—was the smallest since 1900. In 1921 the number increased to 159,499 men, a total 370 less than in 1916. From 1914 to 1918, though the number of men employed decreased 18 per cent, the production increased from 90,821,507 to 98,826,084 net tons, or nearly 9 per cent. From 1914 to 1921 the number of men employed decreased 11 per cent, but the production fell less than 0.4 per cent. That the output did not decrease more in the face of so great a decrease in the number of

employees was due chiefly to more steady operation of the mines. The average number of days worked was 271 days in 1921, against 245 days in 1914. There was also a slight increase—0.03 ton—in the average daily output per man. Because of the long strike in 1922, comparisons of total output between 1914 and 1922 would be misleading, but the average daily tonnage per man during the 151 days in which the anthracite mines worked in 1922 was the highest since 1908.

From 1915 to 1918 there was a steady increase in the number of days the anthracite mines were operated. This increase offset in part the decrease in the number of men employed during the same period. The increase in the output per man per day and per year was augmented by the heavy washery output in 1917 and 1918. In 1919 and 1921, when the slack demand for bituminous coal made it difficult to market the fresh-mined steam sizes of anthracite, washery production declined and the average daily and yearly outputs per man were more nearly comparable with those of preceding years, when the washeries furnished a smaller percentage of the total production of anthracite.

In 1918, when the mines were working nearly full time (293 days out of a theoretical year of 304 working days), it was thought that the practical limit of production with the labor then available had been reached. Transportation disabilities, even in the seasons of greatest demand, have not often affected production seriously in the anthracite fields. Since 1918 there has been an increase in the number of men employed, but in no year has production come within 8,000,000 net tons of the total in 1918. The decrease in the number of days the mines were worked in 1921 as compared with 1917 and 1918, as well as the decrease in washery output, indicates that falling off in demand, rather than shortage in labor, caused the decrease in production in 1921.

The sharp losses in production in 1922 were, of course, directly chargeable to the strike that tied up operations from April 1 to September 9. Although the demand for coal during the first quarter of the year was hardly of typical pre-strike intensity, the major operators in the region kept production at a high rate during the last half of that period by shipping heavily to friendly retail dealers and by putting large stocks of small coal into storage. When operations were resumed the demand for the domestic sizes far exceeded the capacity of the mines, but the same thing was not true of the industrial demand. Much of the coal that ordinarily enters the steam trade, however, was absorbed by the household trade. In some localities the domestic consumer gladly accepted the smaller sizes to piece out his supplies; in others State and local regulations or the actions of the trade itself left him no alternatives.

Whether the prediction made in 1918 that the limit of production with the available labor supply had been reached is to be fulfilled the future alone can tell. Predictions that the anthracite industry had exhausted the possibilities of market demand have been made at intervals stretching back to the early days of the trade. In the years preceding the World War a large part of the raw labor supply for the mines was recruited from foreign sources. The operation of the present restrictive immigration law has, of course, narrowed the possibilities of augmenting the labor supply in that manner. The

Pennsylvania miners' certificate law and the union grip on employment in the anthracite collieries stand in the way of a rapid increase in the number of licensed miners through importation of labor from other States. It would appear, therefore, that the only source from which any substantial increase in the number of qualified miners may be expected is to be found in the ranks of those employed as miners laborers and helpers. Unfortunately, according to the testimony of the United States Coal Commission, relative wage scales and living conditions in that branch of the anthracite mining industry are not of a character to attract large numbers of fresh recruits. The one thing that stands out clearly, however, is the fact that each succeeding year must see an increase in the expenditure of labor per ton of coal produced because of the greater depth of mining and the thinner beds that must be worked unless indeed this tendency is arrested by technical improvements.

The table on page 506, headed "Coal produced per man employed, 1890–1922," shows the number of men employed in the anthracite mines during the last 33 years, the number of days worked and the average output. The average output per man per year is obtained by dividing the total output for the year by the number of men employed. The average output per man per day is obtained by dividing the average per year thus determined by the number of days worked. These averages therefore reflect not only the efficiency of the miners but the changes in the percentage of underground and surface men employed year by year and the proportion of washery product entering into the total output for the year.

MEN EMPLOYED IN THE BITUMINOUS-COAL MINES.

COMPARATIVE SUMMARY.

A new record in the total number of men employed in the bituminous-coal mines of the United States was again made in 1922, when the number reported was 687,958—an increase of 24,204 over the total reported in 1921. In 1918, when all records of production of soft coal were broken, the total number of men employed was 615,305. Any comparison of tonnage for the two years, however, would be obviously unfair, because 1918 represented the crest of the war demand for fuel, augmented by a sharp weather demand in the domestic trade in the early months of the year, whereas the potentialities of 1922 were held in check by the strike. The total number of days worked in 1922 was 142, a new low mark in the Geological Survey's records of the bituminous-coal industry. The average tonnage per man per day, on the other hand, was the highest ever recorded.

The daily output for the 142 days worked in 1922 was equivalent to a total of 916,000,000 tons for a theoretical full-time year of 308 working days. In 1921, a year of great depression, the daily average was equivalent to a full-time production of 860,000,000 tons. In the face of such figures it is hard to understand how the weekly records of operation can report complaints of individual labor shortages, as distinguished from strikes, unless the intimate relation that has existed between labor supply and mine ratings for car supply is also understood. This relation was considered at length in the preceding report of this series.[5] It was hardly a factor of importance in 1922.

[5] U. S. Geol. Survey Mineral Resources 1921, pt. 2, pp. 480–491, 1923.

INSIDE AND OUTSIDE EMPLOYEES.

Another phase of the labor supply not disclosed in the preceding discussion deserves attention—namely, the percentage of inside and outside men employed. In 1916 the percentage of inside or underground employees was 84.5; by 1918 it had dropped to 80.7. In the anthracite mines the percentage of underground labor dropped from 73 in 1916 to 69.1 in 1918. The explanation offered for the proportionate increase in outside or surface labor lay in the market demands of 1917 and 1918. In their efforts to increase the number of men at their mines and thereby their capacity, mine rating, and car supply, operators added any and all labor obtainable, pushed repairs, construction, and development, and, in the anthracite region, added more men to the crews working washeries at the culm banks.

With the slackening in demand that accompanied the postwar slump, the prediction was made that a large proportion of the extra men who had been employed would be dropped and that the percentage of underground workers would be increased. This prediction was fulfilled to a marked degree at the bituminous-coal mines and to a less extent at the anthracite mines. One reason for the progressive decline in the number of surface employees during this period was the fact that some of them were transferred to underground labor. Other causes of the increase in the proportion of underground labor were the return of experienced miners from military service; the slowing up of repair, construction, and development work; and the desire of the operators to cut down the number of day employees and increase the number of piece-work employees at a time when the margin of profit was narrow, as it was in 1921.

The first increase in the number of surface employees at the bituminous-coal mines since 1918 was shown in the figures for 1922. In 1922 the total number of employees was 687,958, or 24,204 more than in 1921. There was an increase of 15,120 in the number of underground workers and of 9,084 in the number of surface workers. This brought the percentages of underground workers to 84.6 per cent, as compared with 84.5 per cent in 1916. In the absence of a more convincing explanation this increase in the number of top men may be ascribed to two causes—the desire of the operators to push ahead development work that had been neglected in 1921, so that the mines might be in a position to concentrate upon production in the event of a sharp revival in demand; and the lure that the maintenance of a high post-war basic wage held out to workers who faced or feared reductions in other industries. Decreases in the total number of employees were reported by the California-Idaho-Oregon group, Colorado, Kansas, Maryland, Michigan, Montana, New Mexico, Oklahoma, Pennsylvania, South Dakota, and Texas. The greatest increase was in Kentucky, where the total number employed rose from 50,521 in 1921 to 60,924 in 1922.

The total number employed at the anthracite mines in 1922 was 22,830 less than in 1914, the peak year for labor supply at those mines. Although the release of men from military duty is plausibly assumed to explain the increase in the number employed in 1919 over that in 1918, it must be assumed, in the absence of detailed analysis, that the decrease in the number employed in 1920—145,074 men as compared with 154,571 in 1919—was due to the drifting

away of men from the mines either to more lucrative employment in some other industry or to work in the bituminous-coal mines, which offer a higher day rate in the union fields than that paid by the anthracite mines, though the working time is less steady. In 1921, when the bituminous-coal mines averaged 149 days, as against 271 at the anthracite mines, and when general industry was at a low ebb, it was not strange that some of those who had left the anthracite mines in 1920 returned to their former work. In 1922, however, the prolonged strike was an incentive to anthracite workers to seek employment elsewhere. Compared with 1921, there was a decrease of 2,650 in the total number of employees, but the loss in the number of surface workers was only 112. Inasmuch as the unionized bituminous-coal mines also were idle during the greater part of the time in which the anthracite workers were on a strike, many of the anthracite workers must have drifted into other fields of activity or to the nonunion bituminous-coal mines during 1922.

The percentage of underground men in the anthracite mines in 1918 was 69.1; in 1919 it rose to 69.8; in 1920 it dropped back to 69.7; in 1921 it was 73.2; and in 1922 it was 72.8. The changes in the relative proportions of underground and surface workers are influenced by the increase and decrease in the number of men employed in culm-bank washeries, who are included with the surface workers.

Men employed in the coal mines of the United States in 1920, 1921, and 1922.

State.	Underground.		Surface.		Total.
	Number.	Percentage.	Number.	Percentage.	
1920.					
Alabama	20,355	79.7	5,185	20.3	25,540
Alaska	105	50.7	102	49.3	207
Arkansas	3,354	84.6	612	15.4	3,966
California and Idaho	8	80.0	2	20.0	10
Colorado	11,005	80.3	2,706	19.7	13,711
Georgia	97	65.5	51	34.5	148
Illinois	76,993	88.4	10,091	11.6	87,084
Indiana	26,922	86.4	4,233	13.6	31,155
Iowa	10,757	90.4	1,148	9.6	11,905
Kansas	7,589	84.5	1,395	15.5	8,984
Kentucky	40,036	81.0	9,416	19.0	49,452
Maryland	4,630	83.5	918	16.5	5,548
Michigan	1,927	89.5	227	10.5	2,154
Missouri	6,865	77.7	1,973	22.3	8,838
Montana	3,424	81.4	780	18.6	4,204
New Mexico	2,940	78.7	798	21.3	3,738
North Carolina	40	80.0	10	20.0	50
North Dakota	753	67.8	357	32.2	1,110
Ohio	42,062	82.7	8,795	17.3	50,857
Oklahoma	6,878	83.4	1,366	16.6	8,244
Oregon	56	65.9	29	34.1	85
Pennsylvania (bituminous)	143,876	82.7	30,094	17.3	173,970
South Dakota	37	78.7	10	21.3	47
Tennessee	9,227	81.3	2,126	18.7	11,353
Texas	2,573	87.2	377	12.8	2,950
Utah	3,559	79.0	945	21.0	4,504
Virginia	10,553	75.3	3,457	24.7	14,010
Washington	3,966	79.4	1,028	20.6	4,994
West Virginia	82,893	80.5	20,057	19.5	102,950
Wyoming	6,332	81.4	1,447	18.6	7,779
Total bituminous	529,812	82.8	109,735	17.2	639,547
Pennsylvania anthracite	101,023	69.7	44,051	30.3	145,074
Grand total	630,835	80.4	153,786	19.6	784,621

Men employed in the coal mines of the United States in 1920, 1921, and 1922—Continued.

State.	Underground.		Surface.		Total.
	Number.	Percentage.	Number.	Percentage.	
1921.					
Alabama	21,173	82.0	4,636	18.0	25,809
Alaska	183	45.6	218	54.4	401
Arkansas	3,163	87.5	453	12.5	3,616
California and Idaho [a]	83	58.9	58	41.1	141
Colorado	11,906	81.9	2,623	18.1	14,529
Georgia	85	62.5	51	37.5	136
Illinois	85,509	89.6	9,922	10.4	95,431
Indiana	28,932	88.5	3,755	11.5	32,687
Iowa	10,412	91.4	974	8.6	11,386
Kansas	6,991	85.2	1,216	14.8	8,207
Kentucky	41,733	82.6	8,788	17.4	50,521
Maryland	3,942	84.4	726	15.6	4,668
Michigan	1,968	89.0	244	11.0	2,212
Missouri	6,971	81.5	1,584	18.5	8,555
Montana	3,460	82.8	718	17.2	4,178
New Mexico	3,855	84.2	722	15.8	4,577
North Carolina	45	75.0	15	25.0	60
North Dakota	775	72.8	289	27.2	1,064
Ohio	44,698	86.3	7,087	13.7	51,785
Oklahoma	7,425	83.9	1,429	16.1	8,854
Oregon	(a)	(a)	(a)	(a)	(a)
Pennsylvania (bituminous)	164,222	86.1	26,421	13.9	190,643
South Dakota	43	100.0			43
Tennessee	8,561	82.7	1,786	17.3	10,347
Texas	2,598	89.8	294	10.2	2,892
Utah	3,491	78.9	931	21.1	4,422
Virginia	9,807	82.3	2,115	17.7	11,922
Washington	3,486	80.4	848	19.6	4,334
West Virginia	84,752	83.2	17,098	16.8	101,850
Wyoming	7,020	82.7	1,464	17.3	8,484
Total bituminous	567,289	85.5	96,465	14.5	663,754
Pennsylvania anthracite	116,817	73.2	42,682	26.8	159,499
Grand total	684,106	83.1	139,147	16.9	823,253
1922.					
Alabama	23,143	82.2	5,026	17.8	28,169
Alaska	262	60.9	168	39.1	430
Arkansas	3,359	83.2	676	16.8	4,035
California and Idaho [a]	45	75.0	15	25.0	60
Colorado	11,069	82.0	2,437	18.0	13,506
Georgia	91	60.7	59	39.3	150
Illinois	86,296	89.6	10,040	10.4	96,336
Indiana	28,893	87.0	4,315	13.0	33,208
Iowa	11,846	92.1	1,011	7.9	12,857
Kansas	6,412	87.1	947	12.9	7,359
Kentucky	50,396	82.7	10,528	17.3	60,924
Maryland	3,226	85.9	529	14.1	3,755
Michigan	1,974	91.1	192	8.9	2,166
Missouri	7,218	82.5	1,532	17.5	8,750
Montana	3,098	85.2	537	14.8	3,635
New Mexico	3,222	80.5	779	19.5	4,001
North Carolina	95	74.8	32	25.2	127
North Dakota	1,136	68.9	512	31.1	1,648
Ohio	45,906	84.7	8,288	15.3	54,194
Oklahoma	6,624	84.6	1,204	15.4	7,828
Oregon	(a)	(a)	(a)	(a)	(a)
Pennsylvania (bituminous)	159,451	84.4	29,387	15.6	188,838
South Dakota	32	100.0			32
Tennessee	9,533	83.3	1,916	16.7	11,449
Texas	2,535	89.2	306	10.8	2,841
Utah	3,629	76.9	1,092	23.1	4,721
Virginia	10,857	81.0	2,542	19.0	13,399
Washington	3,604	80.4	877	19.6	4,481
West Virginia	90,814	82.5	19,200	17.5	110,014
Wyoming	7,643	84.5	1,402	15.5	9,045
Total bituminous	582,409	84.6	105,549	15.4	687,958
Pennsylvania anthracite	114,279	72.8	42,570	27.2	156,849
Grand total	696,688	82.5	148,119	17.5	844,807

[a] California includes Oregon.

Statistics of labor employed in coal mines of the United States, 1920–1922.

State.	1920		1921		1922	
	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.
Alabama	247	25,540	166	25,809	215	28,169
Alaska	240	207	244	401	147	430
Arkansas	176	3,966	112	3,616	81	4,035
California and Idaho	181	10	[a] 149	[a] 141	[a] 250	[a] 60
Colorado	255	13,711	164	14,529	191	13,506
Georgia	294	148	183	136	242	150
Illinois	213	87,084	152	95,431	120	96,336
Indiana	192	31,155	128	32,687	110	33,208
Iowa	250	11,905	148	11,386	131	12,857
Kansas	204	8,984	137	8,207	125	7,359
Kentucky	182	49,452	152	50,521	140	60,924
Maryland	207	5,548	120	4,668	101	3,755
Michigan	261	2,154	196	2,212	162	2,166
Missouri	233	8,838	166	8,555	113	8,750
Montana	250	4,204	143	4,178	140	3,635
New Mexico	302	3,738	150	4,577	216	4,001
North Carolina	288	50	300	60	167	127
North Dakota	218	1,110	194	1,064	175	1,648
Ohio	188	50,857	134	51,785	100	54,194
Oklahoma	217	8,244	141	8,854	114	7,828
Oregon	307	85	(a)	(a)	(a)	(a)
Pennsylvania (bituminous)	244	173,970	151	190,643	154	188,838
South Dakota	133	47	129	43	138	32
Tennessee	234	11,353	154	10,347	163	11,449
Texas	242	2,950	139	2,892	185	2,841
Utah	252	4,504	151	4,422	204	4,721
Virginia	262	14,010	166	11,922	198	13,399
Washington	260	4,994	159	4,334	194	4,481
West Virginia	198	102,950	149	101,850	143	110,014
Wyoming	264	7,779	167	8,484	128	9,045
Total bituminous	220	639,547	149	663,754	142	687,958
Pennsylvania (anthracite)	271	145,074	271	159,499	151	156,849
Grand total	230	784,621	173	823,253	144	844,807

[a] California includes Oregon.

DAYS WORKED BY THE MINES.

METHODS OF REPORTING.

A feature of the Geological Survey's statistical record of the coal industry that is much used by students of the industry is the record of "average number of days worked" by the mines. Thus in the table on page — it is stated that the average number of days worked in 1922 for the State of Arkansas was 81, for the State of New Mexico 216, and for the country as a whole 142. In 1921 the country-wide average was 149 days, and in 1920 it was 220 days. It will be worth while to explain just how this average is computed and what it probably means.

The basis for determining the average number of days worked consists of the replies given to the question asked of every producer: "Total number of full days mine (tipple) was in operation during the year (parts of days should be reduced to equivalent in full days)." If the operators follow the instructions on the card the replies will give the total number of days worked by each tipple during the year, each day consisting of whatever number of hours is established as the standard for that mine. Occasionally an operator fails to reduce the fractional days to the equivalent full-time days and reports not "days worked" but "starts." In a year like 1920, when, because

of shortage of railroad cars, it was a common experience for mines to start operations in the morning and then close before the full eight hours was over, for lack of cars to load, the difference between the number of starts and the number of full-time days might be large. To whatever extent this error is present in the returns made by operators, the time worked by the mines and therefore the amount of employment given to the miners will be overstated. Nevertheless, careful check with the more elaborate reports rendered by operators to the United States Coal Commission on its Form L–1, which calls for the number of hours of tipple operation as well as the number of full-time days, indicates that the error from this source is not a serious one.

In another respect the returns of days of tipple time may fail to indicate the amount of employment offered by the mine, or to give an accurate picture of the time during which the capital and working force about the mine are engaged in producing the reported output. The tipple time is not always an accurate measure of the time worked by the regular force underground—that is, of the "mine time." Under some circumstances, as during the strike of 1922, for example, mines running short handed might dump coal over the tipple only every other day, while men were engaged in cutting and loading coal underground every day in the week. Under such conditions the tipple time would understate the time worked by the mine as a whole, and the result would be to give an exaggerated picture of the hourly or daily productivity under the conditions prevailing. How large an error is introduced into the statistics by such differences between tipple time and mine time has not been determined.

WEIGHTING THE AVERAGE.

To determine the average number of days worked in a particular county, State, or district the figure for each mine is multiplied by the number of men employed at that mine, and the sum of these products for all the mines in the area considered is divided by the sum of the men employed. The reason for thus weighting the average will be clear from an illustration. Let us suppose that in a certain district there are three mines. Mine A, a railroad mine, works 300 days and employs 1,000 men. Mine B, a smaller commercial mine, works 200 days, but employs only 100 men. Mine C is a small mine, serving a local market; it employs 10 men and works only 100 days. The unweighted average for the three mines, no regard being paid to their size, is of course 200 days, but such an average would fail to show the real conditions of employment of labor at the three mines, for obviously most of the men are at work in the large railroad mine and are working very much more than 200 days. In practice, therefore, the Geological Survey computes the weighted average for the three mines as follows:

Mine.	Days worked.	Men employed.	Product of men times days.
A	300	1,000	300,000
B	200	100	20,000
C	100	10	1,000
		1,110	321,000

The final step in the computation is to divide this total of 321,000 man-days by 1,110, the total number of men employed; the quotient, 289, is the weighted average number of days worked by the three mines.

Although this example is obviously an extreme one, it will serve to show the kind of error that may be introduced through failure to weight the average. That this error may be expected, even under the conditions existing in a given field or State, is demonstrated by the following table, in which the working time of all the thousands of mines reporting in the United States is shown first without weighting, then after weighting in the manner just described. In 1921 there were 8,038 commercial mines that reported production to the Geological Survey. The simple average working time, regardless of the relative sizes of these mines, is 130 days. Assigning to the time at each mine a weight corresponding to the number of men employed there makes the average 149 days. Comparison of the weighted and unweighted figures for the other years shown indicates that for the country as a whole the unweighted average will be from 10 to 20 days lower than the weighted average.

Weighted and unweighted average number of days worked by bituminous coal mines in certain years.

Year.	Number of commercial mines.	Average days worked per mine.	
		Unweighted.	Weighted
1905	5,060	193	211
1914	5,602	185	195
1920	8,921	203	220
1921	8,038	130	149

The cause of the difference between the weighted and unweighted average for the country is the fact that large mines work more steadily than small ones. Over the country as a whole the larger the mine the greater the number of days worked by it. To this general tendency some other cause not connected with the size of mine may create exception, but the tendency is nevertheless manifest. The following table shows steady progression in working time with size of output in each of the four years 1905, 1914, 1920, and 1921:

Average number of days worked by all commercial bituminous-coal mines in certain years, classified by size of mine.

	1905	1914	1920	1921
Mines producing yearly:				
0–9,999 tons	139	122	167	65
10,000–49,999 tons	182	163	201	115
50,000–99,999 tons	202	185	215	148
100,000–199,999 tons	213	197	221	168
200,000 tons or more	248	219	242	188
All mines	211	195	220	149

The Geological Survey has from the first found it necessary to weight the reports of days worked by the method above described. A number of the States that collect statistics of mining publish figures of days worked but do not weight them. In the interest of uniformity and accuracy, it is urged that all such statistics should be weighted, and the method used by the Survey is both the simplest and the most accurate.

NUMBER OF MINES WORKING SPECIFIED NUMBER OF DAYS.

Even the weighted average, however, fails to give a true picture of the extraordinary variations in working time from mine to mine. The average is a composite of some mines working as little as 20 or 40 days a year and other mines working full time. In 1921, for example, the average was 149 days, but the following table shows that only 777 mines out of the 8,003 represented fall within the group that includes the average. In the same year there were 524 mines that operated for less than 20 days and 101 mines that worked 300 days or more.

Number of mines in the United States working specified number of days in certain years.[a]

Days of mine operation.	1905		1914		1920		1921	
	Number of mines.	Per cent of total.	Number of mines.	Per cent of total.	Number of mines.	Per cent of total.	Number of mines.	Per cent of total.
Less than 20 days	96	1.9	143	2.6	81	0.9	524	6.5
20 to 39 days	61	1.2	113	2.0	55	.6	566	7.1
40 to 59 days	94	1.9	165	2.9	85	1.0	564	7.0
60 to 79 days	109	2.2	178	3.2	151	1.7	592	7.3
80 to 99 days	114	2.3	178	3.2	182	2.0	663	8.3
100 to 119 days	243	4.8	253	4.5	389	4.4	751	9.4
120 to 139 days	247	4.9	346	6.2	542	6.1	751	9.4
140 to 159 days	438	8.7	447	7.8	804	9.0	777	9.8
160 to 179 days	372	7.4	471	8.4	741	8.3	637	8.0
180 to 199 days	443	8.7	535	9.6	668	7.5	552	6.9
200 to 219 days	978	19.2	808	14.4	1,327	14.9	627	7.8
220 to 239 days	452	8.9	608	10.9	794	8.9	291	3.6
240 to 259 days	599	11.8	559	10.0	1,092	12.3	295	3.7
260 to 279 days	331	6.5	373	6.7	717	8.0	185	2.3
280 to 299 days	192	3.8	223	4.0	826	9.3	127	1.6
300 days or more	291	5.8	202	3.6	453	5.1	101	1.3
	5,060	100.0	5,602	100.0	8,907	100.0	8,003	100.0

[a] Because these figures do not include Alaska, and for other reasons, they differ slightly from those published elsewhere by the Geological Survey.

Grouping mines by number of days worked, however, takes no account of their relative sizes or of the tendency for small mines to work fewer days than do large ones. To present an accurate picture some corrective that will take into account the size of the undertaking is needed, and such a corrective is supplied in part by tabulating the production of the mines falling within each time group, as in the following table. It will be seen that the 524 mines that worked less than 20 days in 1921 were mostly small mines and that they produced in all only 976,000 tons. The bulk of the tonnage was contributed by mines that worked from 120 to 219 days, and 101 mines that worked 300 days or more produced 7,394,000 tons.

Bituminous coal produced in mines working specified number of days in 1921.[a]

Days of mine operation.	Production (net tons).	Percentage of production.		Days of mine operation.	Production (net tons).	Percentage of production.	
		By groups.	Cumulative.			By groups.	Cumulative.
Less than 20 days	976,000	0.2	0.2	180 to 199 days	49,418,000	11.8	65.2
20 to 39 days	3,553,000	0.9	1.1	200 to 219 days	46,856,000	11.3	76.5
40 to 59 days	6,320,000	1.5	2.6	220 to 239 days	30,306,000	7.3	83.8
60 to 79 days	11,713,000	2.8	5.4	240 to 259 days	27,249,000	6.6	90.4
80 to 99 days	20,641,000	5.0	10.4	260 to 279 days	16,340,000	3.9	94.3
100 to 119 days	28,006,000	6.7	17.1	280 to 299 days	16,083,000	3.9	98.2
120 to 139 days	52,835,000	12.7	29.8	300 days or more	7,394,000	1.8	100.0
140 to 159 days	49,431,000	11.9	41.7				
160 to 179 days	48,802,000	11.7	53.4		415,923,000	100.0	

[a] Because these figures do not include Alaska, and for other reasons, they differ slightly from those published elsewhere by the Geological Survey.

MEN EMPLOYED GROUPED BY DAYS WORKED BY THE MINES.

A better corrective to the size of the mine is furnished by the average number of men employed, a figure that is independent of the time worked. Thus, it appears that the 524 mines that worked less than 20 days in 1921 employed 19,263 men. This was 2.9 per cent of the total number of men employed in the mines of the country. The group of 101 mines that worked 300 days or longer employed 8,461 men, or 1.3 per cent of the total number. The largest number of men—81,533, equivalent to 12.4 per cent of the total—were employed in the group of mines that worked from 120 to 139 days.

MINE-WORKING TIME AS A MEASURE OF EMPLOYMENT.

These figures of the average number of days worked by the mines do not necessarily represent the number of days worked by the men in the mines. In the first place, there are always a number of men absent, even when the mine is working, and to get the number of days worked by the men it would be necessary to deduct the days of absence from the mine time. The amount of this absence, whether voluntary or involuntary, has been studied in the reports of the United States Coal Commission on irregularity of employment and absenteeism, by H. B. Drury. It need not concern us here except to state that the commission found that the average time worked by tonnage men is appreciably less than the time worked by the mines themselves. On the other hand, day men of many classes are employed when the tipple is not in operation, and for such men the mine time as here shown understates the amount of employment, even if allowance is made for absenteeism. It is important, therefore, to bear in mind exactly what is meant by the figures in the following table. To refer again to the statistics of 1921, they show, not that 81,533 men worked from 120 to 139 days each, but rather that the average number of employees in mines that worked 120 to 139 days was 81,533. Included in this average number of men were many who worked less than the time reported by their mines and many others, chiefly day men, who worked slightly more than the time reported. If these qualifications are kept in mind, the figures may be used safely to indicate the extraordinary range in the chance to work presented by the

bituminous-coal industry in 1921. It is clear that a uniform day wage rate over the unionized fields would yield annual earnings to men in the mines that worked less than 100 days very different from the earnings of the fortunatemen employed in mines that ran 250 days or more. The inequalities in employment in 1921 were greater than in other years, yet it is characteristic of the figures shown for 1905, 1914, 1916, 1917, 1918, and 1920 that large masses or men were employed in mines that offered very little work, and other masses were employed in mines that ran practically full time.

In the final table of the accompanying series (p. 499) the data are summarized by States, and light is thrown on the comparative oportunities for employment presented by union and nonunion States under the conditions of 1920 and 1921.

Men employed in bituminous-coal mines in the United States working specified number of days in certain years.[a]

Days of mine operation.	Men employed.	Percentage of men.	
		Absolute.	Cumulative.
1905.			
Less than 20 days	1,370	0.3	0.3
20 to 39 days	3,656	.8	1.1
40 to 59 days	5,835	1.3	2.4
60 to 79 days	8,371	1.8	4.2
80 to 99 days	7,926	1.7	5.9
100 to 119 days	12,303	2.7	8.6
120 to 139 days	15,576	3.4	12.0
140 to 159 days	23,401	5.1	17.1
160 to 179 days	29,276	6.3	23.4
180 to 199 days	45,867	10.0	33.4
200 to 219 days	82,647	17.9	51.3
220 to 239 days	56,907	12.4	63.7
240 to 259 days	61,867	13.4	77.1
260 to 279 days	46,059	10.0	87.1
280 to 299 days	28,555	6.2	93.3
300 days or more	30,884	6.7	100.0
	460,500	100.0	
1914.			
Less than 20 days	1,795	0.3	0.3
20 to 39 days	8,203	1.4	1.7
40 to 59 days	15,112	2.6	4.3
60 to 79 days	14,225	2.4	6.7
80 to 99 days	11,925	2.0	8.7
100 to 119 days	17,390	3.0	11.7
120 to 139 days	31,305	5.4	17.1
140 to 159 days	45,159	7.7	24.8
160 to 179 days	55,326	9.5	34.3
180 to 199 days	70,723	12.1	46.4
200 to 219 days	82,237	14.1	60.5
220 to 239 days	89,301	15.3	75.8
240 to 259 days	59,359	10.2	86.0
260 to 279 days	42,312	7.2	93.2
280 to 299 days	27,933	4.8	98.0
300 days or more	11,875	2.0	100.0
	584,180	100.0	
1916.			
Less than 20 days	2,215	0.4	0.4
20 to 39 days	4,256	.8	1.2
40 to 59 days	5,132	.9	2.1
60 to 79 days	5,889	1.1	3.2
80 to 99 days	5,250	.9	4.1
100 to 119 days	10,857	1.9	6.0
120 to 139 days	10,961	2.0	8.0
140 to 159 days	16,098	2.9	10.9
160 to 179 days	23,977	4.3	15.2
1916—Continued.			
180 to 199 days	46,768	8.3	23.5
200 to 219 days	75,892	13.5	37.0
220 to 239 days	79,784	14.2	51.2
240 to 259 days	76,553	13.7	64.9
260 to 279 days	66,261	11.8	76.7
280 to 299 days	62,462	11.1	87.8
300 days or more	68,139	12.2	100.0
	560,494	100.0	
1917.			
Less than 20 days	907	0.2	0.2
20 to 39 days	1,844	.3	.5
40 to 59 days	3,712	.6	1.1
60 to 79 days	3,428	.6	1.7
80 to 99 days	4,104	.7	2.4
100 to 119 days	6,567	1.1	3.5
120 to 139 days	8,647	1.4	4.9
140 to 159 days	14,855	2.5	7.4
160 to 179 days	23,393	3.9	11.3
180 to 199 days	38,901	6.5	17.8
200 to 219 days	61,990	10.3	28.1
220 to 239 days	63,935	10.6	38.7
240 to 259 days	91,817	15.3	54.0
260 to 279 days	95,411	15.8	69.8
280 to 299 days	116,006	19.2	89.0
300 days or more	66,493	11.0	100.0
	602,010	100.0	
1918.			
Less than 20 days	423	0.1	0.1
20 to 39 days	941	.2	.3
40 to 59 days	1,650	.3	.6
60 to 79 days	2,173	.4	1.0
80 to 99 days	2,844	.5	1.5
100 to 119 days	5,279	.9	2.4
120 to 139 days	6,820	1.1	3.5
140 to 159 days	11,624	1.9	5.4
160 to 179 days	17,152	2.8	8.2
180 to 199 days	28,184	4.6	12.8
200 to 219 days	54,847	8.9	21.7
220 to 239 days	78,480	12.8	34.5
240 to 259 days	108,107	17.5	52.0
260 to 279 days	106,121	17.3	69.3
280 to 299 days	127,184	20.6	89.9
300 days or more	61,946	10.1	100.0
	613,775	100.0	

[a] Because these figures do not include Alaska, and for other reasons, they differ slightly from those published elsewhere by the Geological Survey.

Men employed in bituminous-coal mines in the United States working specified number of days in certain years—Continued.

Days of mine operation.	Men employed.	Percentage of men.		Days of mine operation.	Men employed.	Percentage of men.	
		Absolute.	Cumulative.			Absolute.	Cumulative.
1920.				**1921.**			
Less than 20 days	338	0.1	0.1	Less than 20 days	19,263	2.9	2.9
20 to 39 days	917	.2	.3	20 to 39 days	27,280	4.1	7.0
40 to 59 days	2,083	.3	.6	40 to 59 days	27,746	4.2	11.2
60 to 79 days	4,294	.7	1.3	60 to 79 days	36,146	5.4	16.6
80 to 99 days	4,766	.8	2.1	80 to 99 days	49,153	7.4	24.0
100 to 119 days	12,763	2.0	4.1	100 to 119 days	55,016	8.3	32.3
120 to 139 days	32,183	5.0	9.1	120 to 139 days	81,533	12.4	44.7
140 to 159 days	44,321	6.9	16.0	140 to 159 days	75,732	11.4	56.1
160 to 179 days	61,547	9.6	25.6	160 to 179 days	68,432	10.3	66.4
180 to 199 days	54,951	8.6	34.2	180 to 199 days	63,446	9.6	76.0
200 to 219 days	81,259	12.7	46.9	200 to 219 days	55,215	8.3	84.3
220 to 239 days	62,833	9.8	56.7	220 to 239 days	33,940	5.1	89.4
240 to 259 days	83,339	13.0	69.7	240 to 259 days	28,615	4.3	93.7
260 to 279 days	64,505	10.1	79.8	260 to 279 days	16,774	2.5	96.2
280 to 299 days	87,816	13.7	93.5	280 to 299 days	16,701	2.5	98.7
300 days or more	41,466	6.5	100.0	300 days or more	8,461	1.3	100.0
	639,381	100.0			663,453	100.0	

Men employed in bituminous-coal mines working specified number of days in 1920 and 1921, by States.

State.	Total number employed in State.[a]	Per cent of State total employed in mines working number of days specified.															
		Less than 20 days.	20 to 39 days.	40 to 59 days.	60 to 79 days.	80 to 99 days.	100 to 119 days.	120 to 139 days.	140 to 159 days.	160 to 179 days.	180 to 199 days.	200 to 219 days.	220 to 239 days.	240 to 259 days.	260 to 279 days.	280 to 299 days.	300 days or more.
1920.																	
Alabama	25,548		0.2	1.3	1.4	0.4	4.0	2.5	1.5	3.9	2.1	6.2	9.4	7.5	10.1	16.3	33.2
Arkansas	3,967	0.5		.4	2.6	2.0	7.8	4.9	19.8	3.9	17.9	30.7	5.2	2.7	.2	1.4	
California	3		100.0														
Colorado	13,711	.3			1.7	1.1	2.5	3.9	1.4	2.6	2.1	3.2	6.2	9.1	12.6	42.2	11.1
Georgia	148															100.0	
Idaho	7													100.0			
Illinois	87,084			.1	.4	.1	1.3	5.2	5.9	11.4	11.5	16.3	12.1	18.8	13.5	3.1	.3
Indiana	31,155		.4	.2	1.0	.5	.8	4.3	8.1	22.8	19.5	17.7	8.2	8.9	3.5	3.9	.2
Iowa	11,903			.7	.4	.7	.3	.5	1.8	2.1	1.0	8.7	6.6	18.7	47.3	10.8	.4
Kansas	8,984	.2		.9	.8	.7	2.6	5.0	5.7	5.5	10.3	37.0	10.2	14.4	.4	5.4	.9
Kentucky (eastern)	35,075	.1	.1	1.0	.5	2.3	4.6	16.3	16.9	10.2	6.1	9.3	9.9	15.9	3.8	2.8	.2
Kentucky (western)	14,391				1.9	1.5	2.2	8.6	17.4	17.4	5.9	16.8	11.3	11.8	.8	4.4	
Maryland	5,550		.2	.2	.2		1.6	1.1	3.6	11.2	21.1	20.7	25.8	5.6	1.9	5.0	1.8
Michigan	2,154											.7		43.6	47.2	8.5	
Msssouri	8,835		.1	.8	.9	2.2	1.4	2.9	6.3	2.3	5.1	9.3	11.3	10.3	24.5	20.0	2.6
Montana	4,209		.1	.1		.1	1.4	.2	2.7	1.5	2.6	18.2	12.0	5.9	24.4	11.2	19.6
New Mexico	3,735						.1	.1				1.9	.5		.2	16.9	80.3
North Carolina	50															100.0	
North Dakota	1,110		.6	.3	.5	3.4	5.5	2.6	1.9	7.6	3.1	11.8	31.2	7.5	6.5	11.4	6.1
Ohio	50,868		.1	.3	.9	1.4	2.0	8.5	10.6	25.4	14.0	13.0	7.2	6.8	4.2	3.9	1.7
Oklahoma	8,244	.4	1.1	.7	1.8	.5	2.8	.4	1.7	3.5	5.7	19.6	30.9	19.8	3.3	7.6	.2
Oregon	85											2.3		7.1			90.6
Pennsylvania	173,970	.1	.1	.2	.4	.4	1.1	1.9	4.4	5.5	6.3	8.0	8.9	13.9	12.9	27.0	8.9
South Dakota	47	4.3	2.1	10.6	8.5	27.6			6.4	4.3		17.0	8.5	4.3	6.4		
Tennessee	11,356			.4		.7	1.7	2.1	7.9	6.1	3.4	15.0	5.2	20.2	10.9	17.0	9.4
Texas	2,952						.7		2.4	2.3	1.0	1.1	28.3	43.5	11.0	9.7	
Utah	4,504			.1		1.3		.1	.3		6.0	3.2	20.2	27.3	23.1	5.1	13.3
Virginia	14,010	.1			.6	.4	.2	.8	1.4	1.6	4.7	10.5	8.2	6.2	12.0	21.4	31.9
Washington	4,957		.1		1.2	1.6	1.6		.9			3.7	10.4	20.6	18.8	41.1	
West Virginia	102,989	.1	.2	.4	.8	1.0	3.6	8.8	10.5	10.7	10.5	18.8	10.1	10.9	4.8	5.1	3.7
Wyoming	7,780					.4	.1	.3	1.4	5.4	10.8	2.3	.5	3.2	12.0	59.0	4.6
United States	[a]639,381	.1	.2	.3	.7	.8	2.0	5.0	6.9	9.6	8.6	12.7	9.8	13.0	10.1	13.7	6.5

[a] Because these figures do not include Alaska, and for other reasons, they differ slightly from those published elsewhere by the Geological Survey.

Men employed in bituminous-coal mines working specified number of days in 1920 and 1921, by States—Continued.

State.	Total number employed in State.[a]	Per cent of State total employed in mines working number of days specified.														
		Less than 20 days.	20 to 39 days.	40 to 59 days.	60 to 79 days.	80 to 99 days.	100 to 119 days.	120 to 139 days.	140 to 159 days.	160 to 179 days.	180 to 199 days.	200 to 219 days.	220 to 239 days.	240 to 259 days.	260 to 279 days.	280 to 299 days.	300 days or more.
1921.																	
Alabama	25,814	1.6	5.9	1.2	3.0	3.3	6.5	12.6	16.3	8.3	7.2	13.4	8.7	0.6	4.2	.....	7.2
Arkansas	3,618	9.7	5.8	7.0	.4	6.8	15.7	20.7	17.2	.9	9.6	5.2	.5	.5	.....	.....	.....
California	62	.....	100.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Colorado	14,531	.....	3.3	3.6	2.2	2.7	10.7	8.0	9.6	16.0	18.6	12.4	5.6	5.9	.3	.1	1.0
Georgia	136	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.0	.....	.....	.....	.....	.....	.....
Idaho	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.0	.....	.....	.....
Illinois	95,431	2.5	2.5	1.9	4.4	6.4	8.1	13.1	13.6	16.1	13.7	5.4	5.3	4.3	1.9	.3	.5
Indiana	32,689	6.4	3.5	4.4	9.8	11.8	12.1	8.0	14.0	9.4	3.9	7.9	2.9	5.0	.6	.3	.....
Iowa	11,386	.6	1.1	4.6	8.9	5.6	8.9	13.2	18.0	5.4	12.8	11.5	4.0	1.0	3.9	.....	.5
Kansas	8,207	.6	1.7	2.9	3.4	2.5	18.1	20.9	26.6	12.5	4.9	4.6	.....	.9	.....	.1	.3
Kentucky	50,528	2.6	4.0	2.6	4.6	11.2	10.2	8.9	12.2	10.8	4.6	8.6	6.0	4.3	2.7	6.5	.2
Maryland	4,669	11.6	9.1	16.6	7.4	4.9	5.4	2.4	7.1	1.8	2.1	10.1	13.7	7.7	.1	.....	.....
Michigan	2,212	.....	.....	.....	.....	.....	10.4	23.9	6.6	4.6	.....	.....	11.8	35.4	7.3	.....	.....
Missouri	8,555	.....	.7	5.0	10.5	8.2	5.6	7.6	6.4	14.4	8.3	9.5	9.1	8.7	1.9	.3	3.8
Montana	4,178	13.7	5.0	1.1	.5	3.2	13.0	11.2	4.5	11.5	3.8	1.8	29.3	1.1	.....	.....	.3
New Mexico	4,577	.....	.....	.....	.3	3.0	9.4	20.3	46.5	16.6	.....	.2	.3	.6	.....	.....	2.8
North Carolina	60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
North Dakota	1,064	.....	.2	1.9	.9	2.3	3.4	3.0	.9	32.7	13.5	9.4	13.7	2.8	4.9	.4	10.0
Ohio	51,790	5.7	5.5	7.6	4.7	4.7	11.5	11.1	12.1	11.8	6.9	6.2	4.5	2.6	3.0	1.9	.2
Oklahoma	8,855	10.1	1.5	4.7	6.6	9.1	6.8	9.7	10.3	9.3	12.2	4.8	3.3	1.9	6.2	.....	3.5
Oregon	72	.....	.....	4.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	95.8	.....	.....	.....
Pennsylvania	190,698	1.9	4.9	5.2	6.5	8.6	6.7	13.7	8.9	8.0	9.1	7.7	4.6	4.8	3.1	4.5	1.8
South Dakota	43	7.0	4.7	18.6	.....	11.6	2.3	4.7	4.7	.....	.....	46.4	.....	.....	.....	.....	.....
Tennessee	10,345	1.1	3.0	6.1	4.0	8.4	9.6	6.9	7.2	12.7	19.7	4.7	7.4	5.0	2.7	1.5	.....
Texas	2,893	.....	24.7	1.5	2.6	4.1	8.8	8.4	.7	24.2	.....	10.2	1.8	3.2	5.2	4.6	.....
Utah	4,423	.....	1.2	.....	4.0	23.5	4.7	7.8	16.1	7.6	18.9	3.3	.9	3.2	8.8	.....	.....
Virginia	11,922	2.2	3.6	.7	2.4	.6	3.2	14.0	11.9	9.7	14.9	29.0	2.6	3.8	1.4	.....	.....
Washington	4,334	3.9	1.9	5.7	1.3	8.4	5.1	13.1	12.4	.....	.8	33.8	6.2	6.1	1.0	.....	.3
West Virginia	101,870	3.4	4.5	4.7	5.0	7.6	8.2	13.5	9.9	8.0	9.6	9.7	4.7	5.0	2.1	2.8	1.3
Wyoming	8,484	.7	.7	.....	15.1	.8	1.6	7.6	6.2	17.8	27.6	6.2	7.6	3.4	2.6	2.1	.....
United States	[a] 663,453	2.9	4.1	4.2	5.4	7.4	8.3	12.4	11.4	10.3	9.6	8.3	5.1	4.3	2.5	2.5	1.3

[a] Because these figures do not include Alaska, and for other reasons they differ slightly from those published elsewhere by the Geological Survey.

HOURS OF LABOR.

The progress toward a universal establishment of the 8-hour day in the bituminous-coal mines, which had been so accelerated during the war period that the percentage of men employed in mines working 8 hours had risen from 58.6 per cent of the total number of employees at bituminous-coal mines in 1916 to 97.1 per cent in 1920, received a slight check in 1922. In that year the percentage was 95.1, as compared with 96.6 in 1921. This shift brought about an increase of 0.02 hour in the weighted average working day for all mines—the first change in that direction shown in many years. Notwithstanding the decreases noted in 1921 and 1922, the 10-hour day has practically disappeared from coal mines in the United States, and the 9-hour day prevails at only a small proportion of the mines. There are of course certain occupations about the mines for which the working day is longer than that for the mine as a whole, and at some operations men on the tipple work 9 hours although the recognized work day for underground employees is only 8 hours.

The reduction in the percentage of men working at mines having an 8-hour day in 1922 as compared with 1921 was not due to a decrease in the total number of 8-hour mines or in the total number of men employed at such mines. On the contrary the number of mines increased from 7,045 in 1921 to 7,995 in 1922 and the number of men employed from 636,762 to 647,050. The munber of 9-hour mines increased from 230 to 303 and the number of workers employed therein from 18,835 to 26,834; the number of 10-hour mines increased from 68 to 100 and the number of workers therein from 3,427 to 6,156; the number of mines unclassified as to the length of the established working day increased from 695 to 901 and the number of workers therein from 4,730 to 7,918. The total number of mines reported in 1922 was 9,299—an increase of 1,261 over the total for the preceding year. The increase in the number of 8-hour mines was 950, or 75.3 per cent of the total increase. The increase in the number of employees at all mines was 24,204, but the increase in the number of employees at the 8-hour mines was only 10,288, or 42.5 per cent of the total increase. While the mines working more than 8 hours thus apparently gave greater opportunity for new employment, the only real reverse the 8-hour day suffered was in Alabama. In 1921 all but 31 of the mines in that State were operating on an 8-hour basis; in 1922 the total number of mines increased to 280, but the number at which the 8-hour day was in effect dropped from 215 to 140

The length of the working day as stated in the tables that follow refers to the number of hours that the mines are supposed to be in operation, cars and orders permitting, and not to the number of hours the men actually work. In both the anthracite and the bituminous coal fields the actual work of cutting, shooting, and loading the coal is generally paid for at fixed rates per ton, and the men doing this kind of work are known as contract men or tonnage men. The tonnage men are pieceworkers and are not obliged to put in a certain number of hours at their working places. The figures given therefore really indicate the number of hours the men had an opportunity to work during a full day on the assumption that there was a full run of cars and that the market conditions were favorable to full-time operation; they do not mean that all the

tonnage men worked the number of hours stated. Other employees engaged in maintenance, haulage, and repair work are paid by the day, and their hours conform more closely to the established working day of the mine. In some occupations the day men work longer hours than the mine.

From 1903, after the settlement of the anthracite strike, until 1916 the established working day for most classes of labor in the Pennsylvania anthracite region was 9 hours. Since 1916 the basic 8-hour day has prevailed, though a small proportion of the total number of employees have continued under a longer working day.[6]

The decrease in length of the working day must be considered in calculating the productivity per man. In 1903 the weighted average established working day at bituminous-coal mines was 8.7 hours; in 1922 it was 8.06 hours.

Number of bituminous-coal mines in the United States having established working days of certain length and number of men employed, 1921 and 1922.

[Wagon mines not included.]

State.	8 hours.		9 hours.		10 hours.		All others.[a]		Total.	
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Mines.	Men.	Mines.	Men.
1921.										
Alabama	215	22,479	21	1,431	7	554	3	1,345	246	25,809
Alaska	2	150					13	251	15	401
Arkansas	76	3,613	1	3					77	3,616
California	1	62							1	62
Colorado	179	[b]14,305	2	116			32	108	213	14,529
Georgia	1	136							1	136
Idaho	1	7							1	7
Illinois	497	94,590	2	7			173	834	672	95,431
Indiana	256	32,578	2	27			19	82	277	32,687
Iowa	134	11,307			1	4	18	75	153	11,386
Kansas	130	8,109					7	98	137	8,207
Kentucky	602	45,449	43	4,481	17	514	28	77	690	50,521
Maryland	82	4,644			1	6	4	18	87	4,668
Michigan	14	2,212							14	2,212
Missouri	148	8,272	6	201	1	27	16	55	171	8,555
Montana	47	4,154			1	3	10	21	58	4,178
New Mexico	37	4,548	1	20			3	9	41	4,577
North Carolina	1	60							1	60
North Dakota	41	939	1	9	4	49	14	67	60	1,064
Ohio	692	50,854	6	174	4	204	120	553	822	51,785
Oklahoma	124	8,697	2	67	2	80	4	10	132	8,854
Oregon	1	69					1	3	2	72
Pennsylvania (bit.)	2,115	181,572	92	8,244	9	399	181	428	2,397	190,643
South Dakota							18	43	18	43
Tennessee	139	9,977	3	354			1	16	143	10,347
Texas	14	1,571	16	723	5	545	1	53	36	2,892
Utah	33	4,412	1	6			2	4	36	4,422
Virginia	96	11,428	5	241	4	253			105	11,922
Washington	51	4,334							51	4,334
West Virginia	1,253	97,750	26	2,731	12	789	27	580	1,318	101,850
Wyoming	63	8,484							63	8,484
	7,045	636,762	230	18,835	68	3,427	695	4,730	8,038	663,754

[a] Includes employees in mines where the established working day was changed during the year, or where the working day was irregular, or which failed to answer the inquiry.

[b] Includes outside employees working 9 or 10 hours a day at certain mines where the established time for underground workers is 8 hours.

[6] A study made by the United States Coal Commission of the hours worked by 44,003 employees in the anthracite region in April, 1923, showed only 907, or 2.06 per cent, working in excess of 8 hours.

Number of bituminous-coal mines in the United States having established working days of certain length and number of men employed, 1921 and 1922—Continued.

State.	8 hours.		9 hours.		10 hours.		All others.		Total.	
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Mines.	Men.	Mines.	Men.
1922.										
Alabama	140	13,192	70	10,646	23	2,724	47	1,607	280	28,169
Alaska	11	412					2	18	13	430
Arkansas	97	3,930	1	40	1	55	3	10	102	4,035
California [c]	3	60							3	60
Colorado	180	[b]13,187					55	319	235	13,506
Georgia	1	150							1	150
Idaho	[d]	[d]								
Illinois	477	95,338	3	22			131	976	611	96,336
Indiana	253	32,645	1	5			42	558	296	33,208
Iowa	132	12,744					27	113	159	12,857
Kansas	122	7,308					11	51	133	7,359
Kentucky	760	54,782	59	4,755	24	653	57	734	900	60,924
Maryland	76	3,671			1	28	8	56	85	3,755
Michigan	12	2,142					1	24	13	2,166
Missouri	138	8,478	4	64			20	208	162	8,750
Montana	35	3,572					18	63	53	3,635
New Mexico	34	[b] 3,969	1	16			5	16	40	4,001
North Carolina	2	127							2	127
North Dakota	44	1,071			4	152	54	425	102	1,648
Ohio	796	52,777	11	179	10	717	128	521	945	54,194
Oklahoma	118	7,597	3	116	3	96	4	19	128	7,828
Oregon	[d]	[d]								
Pennsylvania (bit.)	2,551	[b]182,403	83	4,218	15	580	226	1,637	2,875	188,838
South Dakota							15	32	15	32
Tennessee	172	10,919	2	530					174	11,449
Texas	15	1,267	12	833	4	465	8	276	39	2,841
Utah	37	4,710	1	10			2	1	40	4,721
Virginia	153	[b]13,028	6	253	3	67	6	51	168	13,399
Washington	47	4,481							47	4,481
West Virginia	1,528	104,047	[e] 46	[e] 5,147	12	619	30	201	1,616	110,014
Wyoming	61	9,043					1	2	62	9,045
Total	7,995	647,050	303	26,834	100	6,156	901	7,918	9,299	687,958

[b] Includes outside employees working 9 or 10 hours a day at certain mines where the established time for underground workers is 8 hours.
[c] California, Idaho, and Oregon.
[d] Included with California.
[e] Includes 816 men working 8 hours prior to September.

Percentage of men employed in bituminous-coal mines that had established working day of 8, 9, and 10 hours, 1903–1922.[a]

Year.	Per cent of total employees in—			Weighted average working day (hours).	Year.	Per cent of total employees in—			Weighted average working day (hours).
	8-hour mines.	9-hour mines.	10-hour mines.			8-hour mines.	9-hour mines.	10-hour mines.	
1903	56.4	17.1	26.5	8.7	1914	60.7	15.4	23.9	8.6
1904	62.1	13.8	24.1	8.6	1915	59.6	17.0	23.4	8.6
1905	61.1	13.6	25.3	8.6	1916	58.6	17.4	24.0	8.6
1906	63.0	13.5	23.5	8.6	1917	79.0	12.6	8.4	8.3
1907	64.0	11.6	24.4	8.6	1918	90.6	6.7	2.7	8.12
1908	63.5	11.1	25.4	8.6	1919	95.5	3.5	1.0	8.06
1910	62.1	11.3	26.6	8.6	1920	97.1	2.0	.9	8.04
1911	62.9	10.9	26.2	8.6	1921	96.6	2.9	.5	8.04
1912	61.6	11.5	26.9	8.6	1922	95.1	4.0	.9	8.06
1913	61.9	15.2	22.9	8.6					

[a] Percentages are calculated on base of total number of men in mines definitely reported as having 8-hour, 9-hour, or 10-hour day. A small number of mines that work more than 10 hours or less than 8 hours have been excluded, as have also all mines for which the reports were defective or which changed their working day during the year.

PRODUCTION PER MAN PER DAY.

METHOD OF COMPUTATION AND VALUE OF THE AVERAGE.

If the total output in a year is divided by the number of men employed the quotient will show the production per man for the year. If this figure in turn is divided by the average number of days the mines worked the final quotient will show the average production per man per day. For the bituminous coal mines in

1922 the average production per man for the year was 609 tons and the average per man per day was 4.28 tons.

The average production per man per day is thus determined by arithmetical calculation rather than by engineering observation. The man who digs the coal gets out considerably more than 4.28 tons per 8-hour day. The average daily product of his work is pulled down by the inclusion of the day men, above and below ground, by the fact that at any one time some of the men supposed to be at work are absent, by the fact that tonnage men frequently go home before the mine as a whole stops, and by the fact that men underground can not work continuously because of unavoidable delays, such as that caused by waiting for mine cars. Nevertheless, the average thus determined is of value because it can be so easily calculated from the records available, and it affords at least a rough indication of the units of labor necessary to raise a ton of coal and prepare it for shipment under the conditions that prevail at any time and place.

AVERAGE DAILY OUTPUT FOR ALL MEN EMPLOYED.

The following table shows the average production per man in each State for 1921 and 1922. No doubt the miners in different parts of the country are unequal in skill and diligence, but the great difference in productivity per man between Missouri, with 2.88 tons per day, and Illinois, with 5.05 tons, for example, is due rather to differences in the physical conditions under which the work is done and particularly to differences in the thickness of the coal beds.

Coal produced per man and average number of days worked per year in the United States in 1921 and 1922, by States.

State.	1921			1922		
	Days mine worked.	Average tonnage.		Days mine worked.	Average tonnage.	
		Per year.	Per day.		Per year.	Per day.
Alabama	166	487	2.93	215	647	3.01
Arkansas	112	340	3.03	81	269	3.32
Colorado	164	628	3.83	191	740	3.87
Illinois	152	729	4.80	120	606	5.05
Indiana	128	622	4.86	110	571	5.19
Iowa	148	398	2.69	131	334	2.55
Kansas	137	422	3.08	125	377	3.02
Kentucky	152	625	4.11	140	684	4.89
Maryland	120	392	3.27	101	318	3.15
Michigan	196	516	2.63	162	429	2.65
Missouri	166	415	2.50	113	326	2.88
Montana	143	654	4.57	140	704	5.03
New Mexico	150	536	3.58	216	779	3.61
North Dakota	194	813	4.19	175	769	4.39
Ohio	134	617	4.60	100	492	4.92
Oklahoma	141	380	2.70	114	356	3.12
Pennsylvania:						
Anthracite	271	567	2.09	151	349	2.31
Bituminous	151	609	4.03	154	592	3.84
Tennessee	154	431	2.80	163	422	2.59
Texas	139	336	2.42	185	389	2.10
Utah	151	922	6.10	204	1,057	5.18
Virginia	166	628	3.78	198	779	3.93
Washington	159	560	3.52	194	575	2.96
West Virginia	149	715	4.79	143	729	5.10
Wyoming	167	849	5.08	128	659	5.15

Still other causes may be found, however, for the changes in the production per man during the last 33 years shown in the table on page 506, giving coal produced per man employed from 1890 to 1922. How much, if any, of the increase in the daily output of bituminous coal per man from 2.56 tons in 1890 to 4.28 tons in 1922 was due to the increased intelligence and application of the individual worker, and how much to better mining methods, introduction of machinery, recovery of slack coal, and superior organization? This question can not be answered precisely, but we do know that there has been a steady increase and that the increase was greater during the last decade than during the two decades preceding it.

The increase in human efficiency in mining bituminous coal is thus clearly evident, but a long record of the average daily output of anthracite per man seems to tell a far different story. The output of anthracite per day per man in 1922, including all coal, fresh mined, washery, and dredge, amounted to 2.31 tons, the highest daily average in a number of years but less than the average for 1908.

Any comparison of the average daily output of either anthracite or bituminous coal from year to year should be made with due consideration for the facts set forth below, which impair the comparability of the figures and render them difficult to interpret.

As the coal that is most easily accessible is mined first, the difficulties of mining increase from year to year, especially in the anthracite region, where the mines are getting deeper, thinner beds are being mined, and more water must be pumped.

As the mines become larger men must spend more time in going from the opening to the working face.

The increase in the value of the coal has encouraged its more complete extraction, which involves an increase in labor per ton raised.

The figures showing "men employed" probably include children. The number of children employed, although small, has been decreasing, a fact which influences the average.

The figures showing production represent only marketable coal. A generation ago it was not uncommon to ship the lumps only and leave the fines either underground or in dumps at the mine mouth. The productivity of the miner then would appear less than if he were credited with both fines and lump, as he is to-day.

During the last 30 years there has been a marked improvement in the care given to the preparation of bituminous coal after it is mined, before shipment. This additional work has tended to increase the number of surface employees.

The most potent factor in the increased output has been the introduction of mining machinery. In 1891 only 5 per cent of the output of bituminous coal was machine mined. In 1900 the proportion was 25 per cent, and in 1922 it had risen to 63.2 per cent. At the same time many other mechanical improvements have been introduced, and all these have increased the output per man.

A small effect, but a growing one, arises from the inclusion in the average output per man of the product of steam-shovel pits, which have a much higher output per man employed than ordinary mines.

A greater effect is that produced by the inclusion in the average daily output of anthracite per man of the results of the operations of dredges and culm-bank washeries, because the daily output of these

operations per man is much higher than that of the deep mines. The production of washery coal, too, may be great or small, for it fluctuates greatly from year to year.

The average daily output is affected by changes in the working day. Such changes, however, have been relatively insignificant except at certain periods of readjustment, such as 1898 to 1903 and 1916 to 1919.

Coal produced per man employed, 1890–1922.

Year.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage.		Men employed.	Days worked.	Average tonnage.	
			Per day.	Per year.			Per day.	Per year.
1890	126,000	200	1.85	369	192,204	226	2.56	579
1891	126,350	203	1.98	401	205,803	223	2.57	573
1892	129,050	198	2.06	407	212,893	219	2.72	596
1893	132,944	197	2.06	406	230,365	204	2.73	557
1894	131,603	190	2.08	395	244,603	171	2.84	486
1895	142,917	196	2.07	406	239,962	194	2.90	563
1896	148,991	174	2.10	365	244,171	192	2.94	564
1897	149,884	150	2.34	351	247,817	196	3.04	596
1898	145,504	152	2.41	367	255,717	211	3.09	651
1899	139,608	173	2.50	433	271,027	234	3.05	713
1900	144,206	166	2.40	398	304,375	234	2.98	697
1901	145,309	196	2.37	464	340,235	225	2.94	664
1902	148,141	116	2.40	279	370,056	230	3.06	703
1903	150,483	206	2.41	496	415,777	225	3.02	680
1904	155,861	200	2.35	469	437,832	202	3.15	637
1905	165,406	215	2.18	470	460,629	211	3.24	684
1906	162,355	195	2.25	439	478,425	213	3.36	717
1907	167,234	220	2.33	512	513,258	234	3.29	769
1908	174,174	200	2.39	478	516,264	193	3.34	644
1910	169,497	229	2.17	498	555,533	217	3.46	751
1911	172,585	246	2.13	524	549,775	211	3.50	738
1912	174,030	231	2.10	485	548,632	223	3.68	820
1913	175,745	257	2.02	520	571,882	232	3.61	837
1914	179,679	245	2.06	505	583,506	195	3.71	724
1915	176,552	230	2.19	504	557,456	203	3.91	794
1916	159,869	253	2.16	548	561,102	230	3.90	896
1917	154,174	285	[a] 2.27	[a] 646	603,143	243	3.77	915
1918	147,121	293	[a] 2.29	[a] 672	615,305	249	3.78	942
1919	154,571	266	2.14	570	621,998	195	3.84	749
1920	145,074	271	[a] 2.28	[a] 618	639,547	220	4.00	881
1921	159,499	271	2.09	567	663,754	149	4.20	627
1922	156,849	151	2.31	349	687,958	142	4.28	609

[a] Heavy washery output.

AVERAGE FOR DEEP MINES PER MAN EMPLOYED UNDERGROUND.

A better index of changes in output per man is the average production of coal from deep mines per man employed underground. This figure, which is given in the following table, eliminates the errors due to inclusion of coal from strip pits, dredges, and washeries and to the variations in the number of workers employed in preparing the coal at the tipple or breaker. Unfortunately the records do not permit a calculation of this average for the years prior to 1911.

It will be noted that this average deep-mined coal per man employed underground fluctuates less than the simple average of all coal per man employed.

The average for bituminous coal shows a fairly steady increase from 1911 to 1922, amounting in all to 0.97 ton, or 24 per cent. In the meantime the length of the established working day had declined from 8.6 hours in 1911 to 8.06 hours in 1922. The average for anthracite, on

the other hand, shows but little change during the period, for the average in 1922 was 2.87 net tons, against 2.75 tons in 1911. This figure, like that for bituminous coal, makes no allowance for changes in the length of the working day.

Coal produced from deep mines per man employed underground per day worked, in 1911–1922, in net tons.[a]

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1911	2.75	4.01	1917	2.89	4.51
1912	2.69	4.24	1918	2.94	4.62
1913	2.67	4.16	1919	2.81	4.64
1914	2.67	4.28	1920	2.93	4.80
1915	2.78	4.49	1921	2.70	4.86
1916	2.74	4.57	1922	2.87	4.98

[a] In making this computation certain estimates had to be made of the division of workers above and below ground and of the production of strip pits in the years 1911 to 1913. The probable error introduced by these estimates is too small to impair the value of the averages.

PRODUCTION PER MAN PER DAY BY METHOD OF MINING.

Next to thickness of seam, the method of mining has probably the largest influence upon the output per man per day of a given mine or district. To measure the relative productivity of labor employed under different methods of mining, the production per man employed per day worked by the mines has been calculated for mines where the predominant method is undercutting by hand, shooting from the solid, and mining by mining machines, and also for open-pit or strip mines. The computations were made by the senior author in cooperation with the President's Conference on Unemployment and with the United States Coal Commission. They cover the years 1914, 1920, and 1921. It is not uncommon for two methods of mining to be used in the same mine—for example, mining by hand and by machine. Such a mine has been classified on the basis of the method by which the larger part of its output was produced during the year considered. The relative importance of the several methods in each State may be judged from the tables of tonnage mined by different methods on page 508. The mines represented by the column headed "Not classified" are chiefly local mines that failed to answer the question, and in most of them the method is either shooting from the solid or mining by hand. In the statistics for 1914 strip pits were not distinguished from other mines. They were probably included with the total "mined by machine"or "not classified." The statistics for 1920, perhaps the most representative year of the three shown, indicate a progressive increase in output per man per day from 3.37 tons in mines where hand methods predominate to 3.50 in mines shooting from the solid, 4.29 in machine mines, and 6.74 in strip pits. In other words, a hundred men employed in a machine mine appear to get out, on the average, 23 per cent more coal than a like number of men working in mines shooting from the solid, and a hundred men in a strip pit will produce 57 per cent more than in a machine mine and nearly twice as much as in a mine employing shooting from the solid.

Bituminous coal produced per man per day in certain years, by method of mining.

[Total tons produced divided by number of men days worked. Surface workers included.]

State.	Mined by hand.	Shot from solid.	Mined by machine.	Not classified.	Total.
1914.					
Alabama	3.11	2.87	2.76	6.00	2.87
Arkansas	2.50	2.85	3.42		2.95
Colorado	3.14	3.69	3.61	1.91	3.35
Illinois	2.27	4.21	4.74	4.03	4.18
Indiana	3.21	3.87	4.74	4.04	4.26
Iowa	1.82	2.43	2.28	1.83	2.26
Kansas	2.31	3.02	1.14	3.45	2.86
Kentucky	3.04	3.52	3.97	2.49	3.76
Maryland	3.15	3.67	2.89	3.42	3.17
Michigan	.95	2.04	2.30		2.28
Missouri	1.67	2.89	1.77	2.85	2.24
Montana	3.87	4.16	4.08	3.41	4.00
New Mexico	2.81	4.50	2.89	2.31	3.28
North Dakota	2.64	3.36	5.21	3.20	3.95
Ohio	2.79	2.99	3.91	3.42	3.78
Oklahoma	1.94	2.27	2.05	1.89	2.41
Pennsylvania	3.39	3.84	3.92	3.67	3.77
Tennessee	2.86	2.53	2.63		2.67
Texas	1.88	3.32			2.12
Utah	3.72	3.44	3.33		3.58
Virginia	3.61	3.65	3.71		3.68
Washington	3.33	2.27	3.24	3.33	2.77
West Virginia	4.35	4.56	4.61	4.10	4.52
Wyoming	4.00	3.92	4.34		4.16
Other States [a]	1.67	1.50		1.51	1.51
	3.29	3.29	4.05	3.18	3.71

State.	Mined by hand.	Shot from solid.	Mined by machine.	Strip pits.	Not classified.	Total.
1920.						
Alabama	2.54	2.72	2.30	3.23	2.65	2.54
Arkansas	2.96	3.02	1.81	3.33	3.47	2.94
Colorado	3.22	5.27	3.67		2.71	3.51
Illinois	3.20	4.59	5.02	9.71	2.45	4.78
Indiana	4.64	4.40	5.03	8.55	2.60	4.84
Iowa	1.90	2.94	2.53		1.97	2.62
Kansas	2.52	3.01	1.10	7.07	2.91	3.13
Kentucky	2.91	3.37	4.15		1.99	3.93
Maryland	3.38	3.61	4.16		3.33	3.50
Michigan	2.67		2.65			2.65
Missouri	1.70	2.84	1.81	6.58	2.04	2.56
Montana	4.99	4.16	4.19		1.97	4.19
New Mexico	3.40	2.39	3.27		1.57	3.27
North Dakota	2.50	3.54	3.63	7.43	2.23	3.64
Ohio	2.87	3.06	4.82	7.53	2.83	4.74
Oklahoma	3.51	2.58	2.76	3.79	2.31	2.71
Pennsylvania	3.52	3.59	4.15	5.18	2.97	3.96
Tennessee	2.73	2.32	2.58	3.00	2.80	2.49
Texas	1.99	3.96	1.28		4.74	2.26
Utah	4.10	3.69	5.96		3.33	5.29
Virginia	2.29	2.95	3.07		2.50	3.04
Washington	2.72	3.39	2.35			2.87
West Virginia	4.05	2.46	4.61	2.38	2.39	4.37
Wyoming	4.12	4.00	5.10			4.66
Other States [b]	.79	1.17			1.85	1.05
	3.37	3.50	4.29	6.74	2.60	3.99

[a] Includes Georgia, Idaho, North Carolina, Oregon, and South Dakota.
[b] Includes California, Georgia, Idaho, North Carolina, Oregon, and South Dakota.

Bituminous coal produced per man per day in certain years, by method of mining— Continued.

State.	Mined by hand.	Shot from solid.	Mined by machine.	Strip pits.	Not classified.	Total.
1921.						
Alabama	3.0	3.0	2.8	3.8	2.1	2.9
Arkansas	2.8	3.2	2.1	6.0	2.9	3.0
Colorado	3.8	5.6	3.8		2.8	3.8
Illinois	3.3	4.5	5.1	8.9	2.6	4.8
Indiana	4.1	4.4	5.1	8.1	2.5	4.9
Iowa	2.1	3.0	2.3		2.1	2.7
Kansas	2.5	2.9	1.6	7.6	3.3	3.1
Kentucky	3.4	3.6	4.2	1.0	2.2	4.1
Maryland	3.2	3.1	5.1		2.9	3.3
Michigan	2.0		2.6			2.6
Missouri	1.5	2.5	2.1	7.8	1.6	2.5
Montana	4.5	4.7	4.7		2.2	4.6
New Mexico	4.0	2.8	3.1		2.5	3.6
North Dakota	5.1	3.8	3.8	8.6	3.9	4.2
Ohio	2.7	3.1	4.5	10.9	2.6	4.6
Oklahoma	3.6	2.4	2.3	5.3	2.9	2.7
Pennsylvania	3.7	3.7	4.2	7.6	2.7	4.0
Tennessee	2.8	2.7	3.0	2.0	2.5	2.8
Texas	2.2	4.4	1.1			2.4
Utah	5.6	3.2	6.3			6.1
Virginia	1.8	3.5	3.9			3.8
Washington	3.4	4.3	2.4		4.3	3.5
West Virginia	4.3	3.6	4.9	12.5	2.8	4.8
Wyoming	4.4	4.5	5.2			4.9
Other States[b]	1.3	1.7			1.1	1.5
	3.6	3.7	4.4	8.0	2.6	4.2

HOW PRODUCTIVITY PER MAN VARIES WITH SIZE OF MINE.

Differences in method of mining probably constitute one of the underlying causes that explain the relation between size of mine and productivity per man employed. In a study of the records of the Geological Survey for 1905, 1914, 1920, and 1921—four typical years—made in collaboration with the President's Conference on Unemployment, it was found that the production per man employed per day worked showed a tendency to increase as the size of the mine increased. Thus, in 1921, when the average for all mines was 4.20 net tons per man per day, the mines producing less than 10,000 tons showed an average of 2.70 tons; those in the next higher class, producing between 10,000 and 50,000 tons, had an average output per man per day of 3.45 tons; those in the next higher class had 3.98 tons; those in the class producing from 100,000 to 200,000 tons 4.26 tons; and the largest mines, those with an output of 200,000 tons or more, 4.73 tons. The same progressive increase in productivity with size of the mine was revealed by the reports for 1905, 1914, and 1920.

Bituminous coal produced per man employed per day worked at all commercial mines in certain years, in net tons.

	1905	1914	1920	1921
Mines producing yearly—				
0 to 9,999 tons	1.96	2.29	2.36	2.70
10,000 to 49,999 tons	2.52	2.91	3.24	3.45
50,000 to 99,999 tons	2.90	3.35	3.80	3.98
100,000 to 199,999 tons	3.34	3.78	4.10	4.26
200,000 tons or more	3.80	4.18	4.50	4.73
All mines	3.24	3.71	4.00	4.20

CHANGES IN THE PRODUCTIVITY PER MAN PER DAY IN PROSPERITY AND DEPRESSION.

The following discussion of changes in the efficiency of productivity of labor in periods of business activity and periods of depression is taken from a paper entitled "The bituminous-coal industry in prosperity and depression," by David L. Wing and F. G. Tryon, presented before the mining statistics session of the American Statistical Association, December 28, 1923:

It is a part of the accepted theory of business cycles that the efficiency or productivity of labor is diminished in time of great prosperity and reestablished in times of depression. The theory runs that when work is plentiful and wages are high workmen become careless, employers are forced to take on inefficient men, the power to discharge can not be exercised, discipline is relaxed, and there may be deliberate soldiering on the job or restriction of output. Conversely, the theory runs that during the depression the less efficient men are dismissed, those who remain work harder, shorter hours prevent fatigue from limiting productivity, discipline and attendance improve, and in other ways the quality of service rendered is raised.

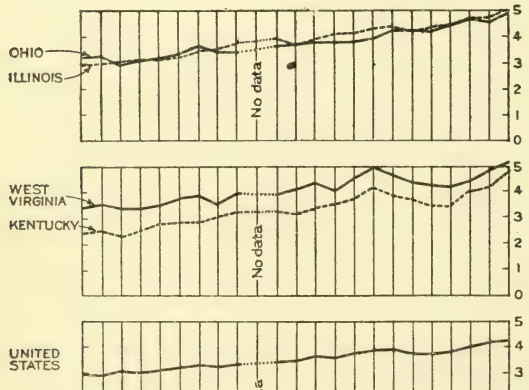


FIGURE 21.—Bituminous coal produced per man per day, 1900–1922. Computed from reports of operators to the United States Geological Survey by dividing the total production in tons by the product of the average number of days worked by the mines and the average number of men employed.

This theory is supported by a very considerable body of expert opinion and evidence from employers, labor managers, and students, but it is difficult to establish quantitatively beyond dispute. For the coal industry, however, there exists a mass of quantitative evidence which should go far to measure the efficiency of labor in the alternating booms and slumps of the business cycle.

The measurement of output per man is relatively simple in the coal industry because the product can be so easily measured. The statistical records of the Geological Survey cover for each year the total production in tons, the average number of men employed, the average number of full-time days worked by the mines, and the length of the established working day. Dividing the total output by the product of the number of men employed in the mines and the number of days worked by the mines gives the average output per man employed per day worked. * * * The average is not an engineering observation but an arithmetical computation, and the original returns upon which it is based contain a good many errors. With due allowance for these defects, the average per man per day still has unique value because the errors are probably constant from year to year and because, therefore, change in the average shows the trend clearly. In Figure 21 has been plotted the course of this average for some of the large coal-producing States from 1900 to 1922. It would be interesting to show also the figures for the decade 1890 to 1899 and trace the change in productivity through the great depression of 1893, but this can not be done with certainty, because there is no record of the length of the working day at that period, and changes from the 9 or 10 hour day to the 8-hour day would of course affect the comparability of the averages.

All the curves of the chart have an upward trend, indicating steady increase in the production per man per day. This does not mean necessarily that the coal miners are working harder in 1923 than they did in 1903, nor that they are more skillful. The primary reason for the increase is rather the steady introduction of mining machines, the improvement of equipment, and other advances in the

art of mining. The curves show simply that the sum total of plant, labor, and management now produces much more per unit of labor expended than it did 20 years ago.

Between the figures for one year and those for the next, however, the change introduced by improvement in technique is so small that it may be disregarded, and if there is any great variation in the attitude of the men toward the job as shown in their diligence and industry, we should expect to find it expressed in sharp fluctuations in the curve between years of activity and high earnings and subsequent years of dullness and low earnings. But as a matter of fact the curves are strangely regular. Those for Ohio and Illinois in the top section show a steady increase, and the small irregularities are probably as much the result of errors in the data as of any great change in the efficiency of the men.

The curves for the nonunion States of West Virginia and Kentucky, shown in the third section of the chart, at first sight appear to bear out the theory of change in efficiency of labor. Both curves show an increase in 1914 and 1915, which were years of general depression, and a quick decrease in the boom years 1916 to 1918. But this apparent drop is largely explained by the adoption of the 8-hour day. In 1916 practically all mines in West Virginia worked 9 hours, or longer. By 1920 practically all had made the change to the 8-hour day. The weighted average workday for the State in 1916 was 9.4 hours. The weighted average workday in 1917 was 8.5 hours, and by 1919 it had dropped to 8.1 hours. This change in the length of the unit of time is just about equal to the reduction in output per day, and what was true of West Virginia was true of Kentucky, Virginia, and Alabama. In Virginia as late 1916 the 10-hour day was almost universal, and it has now been replaced by the 8-hour day. Alabama changed from 10 hours, or even longer, in 1915 to 8 hours in 1919, only to start back toward the longer day in 1922, when the weighted average workday in Alabama was 8.6 hours.

It is this change in the length of the working day in the nonunion fields that accounts for the slight depression in the curve of output per man per day for the country as a whole from 1916 to 1919 shown in the bottom section of the diagram. There was a slight decline in output per man per day in the boom year 1907 and a corresponding increase in 1908, but both changes are so small that they may well be due to some error in the figures rather than to a change in the attitude of the men.

The same method of analysis applied to the records of small districts, individual companies, or mines often shows a sharp increase in output per man during a depression, but many such changes appear accidental and are offset by other changes in the opposite direction.

There are, however, certain factors that tend to raise the output per man in a year of depression. These include closing of the less efficient high-cost mines increase in the percentage of machine-mined coal, and the tendency of operators to postpone development work. How much they tend to increase the average can not be stated with precision, but any allowance for them leaves small room in the figures for any variation in the efficiency of the individual worker. The evidence, so far as it goes, appears to show that in a broad sense the miners turn out just about as much coal per shift in one year as in another.

In partial explanation of this lack of variation may be cited the fact that the manager of a coal mine does not discharge the less efficient workers during a depression. They may be transferred from day work to tonnage work, but so long as the mine runs at all the operator is generally glad to keep them on the roll. For this reason manufacturing might show an increase in output per worker during a depression when coal mining did not.

The conclusion suggested by these broad statistical averages should be tested by intensive studies of individual mines. The problem deserves attention from the engineers.

To avoid misunderstanding, we wish to make it clear that we are here attempting no comparison of productivity under union and nonunion conditions, but are concerned solely with the question whether the output per man rises or falls with the changes of the business cycle.

Bituminous coal produced per man per day, 1900–1908, 1910–1922, in net tons.

[Computed by dividing the total production in tons by the product of the average number of days worked by the mines and the average number of men employed. No data available for 1909.]

Year.	Total United States.	Ohio.	Indiana.	Illinois.	Pennsylvania.	Colorado.	West Virginia.	Kentucky.
1900	2.98	3.20	2.78	2.92	3.56	2.66	3.36	2.43
1901	2.94	3.29	2.75	2.97	3.53	2.54	3.55	2.49
1902	3.06	3.02	2.98	3.08	3.52	3.16	3.38	2.35
1903	3.02	3.05	3.22	3.21	3.40	3.28	3.36	2.54
1904	3.15	3.20	3.14	3.13	3.70	3.14	3.49	2.71
1905	3.24	3.35	3.11	3.29	3.57	3.14	3.74	2.87
1906	3.36	3.65	3.30	3.49	3.68	3.32	3.86	2.98
1907	3.29	3.45	3.38	3.59	3.61	2.94	3.54	3.02
1908	3.34	3.44	3.85	3.79	3.51	3.13	3.98	3.24
1910	3.46	3.61	3.67	3.95	3.61	3.20	3.94	3.26
1911	3.50	3.73	3.68	3.73	3.69	3.42	4.05	3.18
1912	3.68	3.77	3.88	3.95	3.89	3.72	4.31	3.38
1913	3.61	3.83	4.06	4.10	3.78	3.36	4.07	3.51
1914	3.71	3.84	4.27	4.18	3.75	3.32	4.52	3.79
1915	3.91	3.94	4.17	4.35	4.00	3.60	4.89	4.11
1916	3.90	4.26	4.48	4.42	3.91	3.43	4.68	3.91
1917	3.77	4.26	4.52	4.22	3.80	3.33	4.35	3.72
1918	3.78	4.24	4.45	4.37	3.81	3.36	4.22	3.50
1919	3.84	4.41	4.72	4.48	3.96	3.88	4.18	3.49
1920	4.00	4.73	4.36	4.78	3.96	3.51	4.39	3.95
1921	4.20	4.60	4.86	4.80	4.03	3.83	4.79	4.11
1922	4.28	4.92	5.19	5.05	3.84	3.87	5.10	4.89

STRIKES AND LOCKOUTS.

SCOPE AND VALUE OF THE STATISTICS.

Strikes or "suspensions" of mining were a regular occurrence in the period before the war at the expiration of the biennial wage agreements between the United Mine Workers and the operators. The war years themselves were remarkably free from strikes, but the years of readjustment that followed the war were marked by several widespread and bitterly contested struggles between operators and men. The general bituminous coal strike of 1919 was the largest on record up to that time; 453,418 men were on strike at one time or another; they were out an average of 35 days, and the total number of man-days of idleness was 15,761,410. But that strike, formidable as it seemed at the time, was small compared with the great strike of 1922, which involved 603,031 men for an average of 122 days and which caused a loss of 73,497,000 man-days. It is significant that the struggles of both 1919 and 1922 occurred in periods of rapidly changing prices. In both a change in the wage scale was the principal point at stake, although in the earlier strike it was the miners who sought to force an increase and in the later one the operators who asked for a reduction.

These statistics are based on reports received from the operators, submitted in writing, but not under oath, in reply to the question "Were there any strikes at the mine during the year? If so, give number of men on strike and duration of strike in days (Sundays and holidays excluded)." The operator is not asked to state the cause of the strike—a subject on which his opinion might differ from that of his employees. He is asked, however, to determine whether a particular stoppage is or is not a strike. Naturally, therefore, the operators have reported as "strikes" some stoppages that the employees would have considered "lockouts," and for this reason the tables given are here headed "Strikes and lockouts."

Reports of this kind that have been submitted by one party to a controversy should, if possible, be checked by evidence given by others.

Beginning with 1917, it has been possible to obtain such checks for strikes affecting any considerable number of mines. Weekly reports of shipments furnished by the railroads have measured the extent to which the movement of coal outside of a given area was in fact curtailed by an alleged strike. The statement of the operators have been checked by accounts in newspapers and trade journals and, where it seemed necessary, by questioning representatives of the miners. For the six years from 1917 to 1922, inclusive, the returns have been personally examined by the senior author, who is satisfied that as far as district strikes and general suspensions are concerned they are substantially correct. It has not been possible to check the reports of petty strikes, but they are relatively unimportant in terms of man-days of idleness. Subject to these qualifications the statistics here presented are unique and are of peculiar value, because they are comparable, continuous, and quantitative.

STATISTICAL RECORD.

The first of the accompanying tables gives the statistical record of strikes and lockouts during the last 24 years. For each year are shown the munber of men on strike, the total man-days of idleness, and the average number of days each man on strike was idle.

Summary of strikes and lockouts in the coal mines of the United States, 1899–1922.

Year.	Number of men on strike.	Total man-days idle.	Average number of days lost per man striking.	Year.	Number of men on strike.	Total man-days idle.	Average number of days lost per man striking.
1899	45,981	2,124,154	46	1911	41,413	983,737	24
1900	131,973	4,878,102	37	1912	311,056	12,527,305	40
1901 [a]	20,593	733,802	35	1913	135,395	3,049,412	22.5
1902	200,452	16,672,217	83	1914	161,720	11,013,667	68
1903 [a]	47,481	1,341,031	28	1915	67,190	2,467,431	37
1904	77,661	3,382,830	44	1916	170,633	3,344,586	20
1905	37,542	796,735	21	1917	160,240	2,348,399	15
1906	372,343	19,201,348	51.5	1918	79,395	508,526	6
1907 [a]	32,540	462,392	14	1919	453,418	15,761,410	35
1908 [a]	145,145	5,449,938	38	1920	282,419	5,914,473	21
1909	25,534	731,650	29	1921	151,263	3,106,103	21
1910	218,493	19,250,524	88	1922	603,031	73,497,043	122

[a] Bituminous coal mines only. No strikes of consequence occurred in the anthracite region in these years.

It would be misleading, however, to show the days lost on account of strikes without at the same time showing the days lost through other causes.

In the 23-year period from 1900 to 1922 the operators reported a total loss of 207,422,661 man-days through strikes, but the loss attributable to other causes was 1,282,670,000 man-days, a loss six times as great as that through strikes. To state it in another way, in slightly over two decades American coal miners lost 1½ billion working days, of which 14 per cent was ascribable to strikes and about 86 per cent to other causes, chief of which are no market, car shortage, and mine disability. The man-days lost on account of other causes are calculated from the operators' reports of number of days of mine operation and number of men employed, the full working year being taken as 308 days.

The time lost through "suspensions" during the period of the biennial wage negotiations between the termination of one agree-

ment and the signing of another is included in the statistics as loss through strikes or lockouts. That the greater part of the loss is due to such "suspensions" is seen from the fact that, with few exceptions, the years of large losses by strikes are the "even" years in which the wage negotiations occurred, particularly 1902, 1906, 1910, 1912, 1914, and, most conspicuous of all, 1922. The losses by strikes in the "odd" years have been, by comparison, small, except in 1919, when a general strike of union bituminous miners was called.

Even under the extraordinary conditions of 1922, when all members of the union outside of Kentucky and many thousands of non-union miners as well were on strike for an average of 122 days, the time lost on account of causes other than strikes reached the large total of 65,186,000 man-days, a figure nearly as great as the loss ascribed to the strike itself, which amounted to 73,497,000 man-days.

Prior to 1922 the year in which the largest number of man-days was lost on account of strikes was 1910, yet the 19,250,524 days lost by strikes in that year amounted to only 30 per cent of the total days lost, for a loss of 44,693,242 man-days was due to causes other than strikes. The total loss for all causes in that year was slightly less than that in either the year before or the year after. As 1910 established a new record for production, these figures illustrate the well-known fact that American bituminous-coal mines are developed so far above the demand that full-time operation, year in and year out, is not obtainable.

It does not always follow that if the men in a district had not been on strike they could have worked, because some other cause of non-operation, such as no market or car shortage, might have kept the mines idle.

Days lost at coal mines in the United States on account of strikes and lockouts compared with days lost for other causes, 1900–1922.

[Includes both anthracite and bituminous coal mines.]

Year.	Days lost.		
	On account of strikes and lockouts.	On account of no market, car shortage, and similar difficulties.	Total.
1900	4,878,102	38,122,900	43,001,002
1901 [a]	733,802	43,780,311	44,514,113
1902	16,672,217	40,635,223	57,307,440
1903 [a]	1,341,031	48,517,726	49,858,757
1904	3,382,830	59,860,350	63,243,180
1905	796,735	59,267,036	60,063,771
1906	19,201,348	44,595,142	63,796,490
1907 [a]	462,392	52,235,292	52,697,684
1908 [a]	5,449,938	72,731,214	78,181,152
1909	731,650	64,332,335	65,063,985
1910	19,250,524	44,693,242	63,943,766
1911	983,737	63,044,708	64,028,445
1912	12,527,305	47,506,725	60,034,030
1913	3,049,412	49,376,615	52,426,027
1914	11,013,667	66,242,288	77,255,955
1915	2,467,431	69,836,505	72,303,936
1916	3,344,586	49,214,165	52,558,751
1917	2,348,399	40,401,898	42,750,297
1918	508,526	38,001,284	38,509,810
1919	15,761,410	61,023,906	76,785,316
1920	5,914,473	55,732,698	61,647,171
1921	3,106,103	108,332,246	111,438,349
1922	73,497,043	65,186,691	138,683,734
Total, 23 years	207,422,661	1,282,670,560	1,490,093,161

[a] No serious strikes occurred in the anthracite region in these years.

REVIEW FOR 1922.

The causes of the great strike of 1922 and the merits of the controversy are beyond the scope of the present discussion, the purpose of which is rather to measure the extent of the strike and its effect upon the supply of coal. In the bituminous coal fields a total of 460,589 men were on strike at one time or another during the year. The walkout of the anthracite miners involved 142,442 men, and the total in both branches of the industry was 603,031.

In the bituminous coal fields the deadlock was broken by the Cleveland agreement, which was concluded on August 15 and 16, 114 working days after the beginning of the strike. The agreement, once signed, was accepted by practically all the union districts in rapid succession. By Saturday, August 19, it had been signed by the majority of operators in Ohio, the Fairmont field, and Michigan and in part of central Pennsylvania, and coal was already beginning to move from these mines.

During the following week (August 20 to 26) local wage conferences were held and agreements signed in the Kanawha and Michigan sections of West Virginia, in Montana, Illinois, Indiana, Wyoming, the Southwest interstate field, and central Pennsylvania. This left only two of the strongly organized districts. In the State of Washington an agreement was signed on Monday, August 28. The first signatures of important operators in the Pittsburgh district were reported on the same day, and by Wednesday, August 30, the signature of the largest producer of the Pittsburgh district was recorded.

Thus, by Labor Day the Cleveland agreement had been accepted in all the strongly organized bituminous districts. The strike continued, however, in fields of two types. The first type was represented by formerly nonunion territory in which men had struck and continued to hold out for recognition and wage contracts. To this group belong the controversies in the Connellsville district and in parts of Westmoreland, Somerset, and central Pennsylvania. Examples of the second type of field were the Chesapeake & Ohio section of Kanawha and part of the Georges Creek and upper Potomac region, fields where the operators were unwilling to renew the agreements formerly in effect that had expired on March 31. In fact in some of these districts the strike was not called off until 1923, and the end of 1922 found many men in tent colonies and many mines still closed. Under such conditions the average time lost per man on strike—117 days—is a composite result of a wide range of factors: Thus in Texas the men on strike remained out an average of 20 days, whereas in Maryland they were out 155 days.

The anthracite strike was settled by the Philadelphia wage agreement, which was formally ratified by the tridistrict convention of the mine workers on Saturday, September 9. Work was resumed the following Monday, and the average time lost per striker from April 1 to September 11 was 138 days.

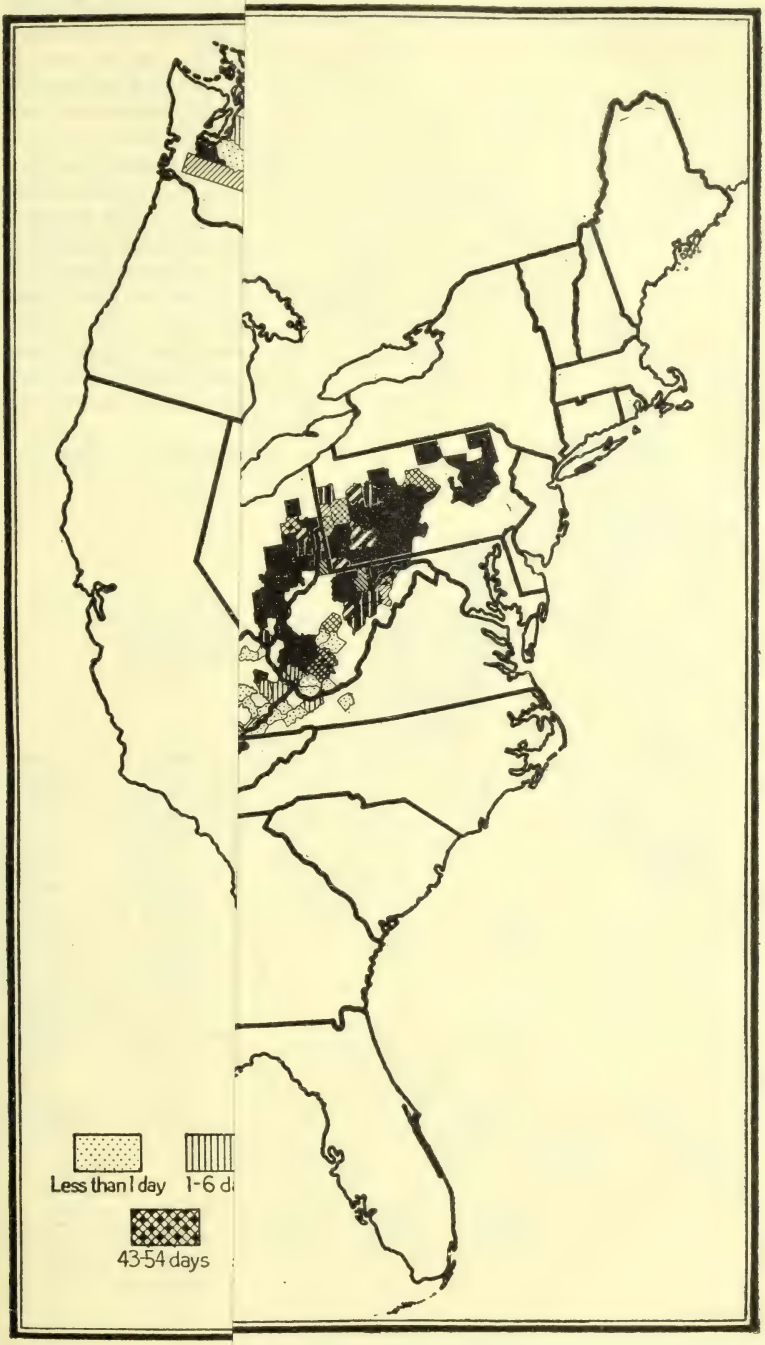
How the miners in the several States responded to the strike call is shown in the next table. The record for the union States requires no explanation. In the strongly organized districts practically all men ceased work, except the pump men and other maintenance men. Here and there mines serving purely local trade or mines whose product was consumed entirely by the owner, as in

an associated brickworks, remained in operation. In a number of districts otherwise entirely closed by the strike strip pits continued to operate, their workmen not recognizing the jurisdiction of the United Mine Workers of America. Locally, also, union men were permitted to continue repair or construction work about the mine under special arrangements between the union and the operator. In still other districts, including the Southwest interstate field, coal continued to move from cooperative mines or from small workings opened by miners themselves, while the commercial properties were idle through the strike. All these exceptions, however, serve but to emphasize the completeness of the paralysis of the usual commercial supply in the strongly organized fields. (See Pl. V.)

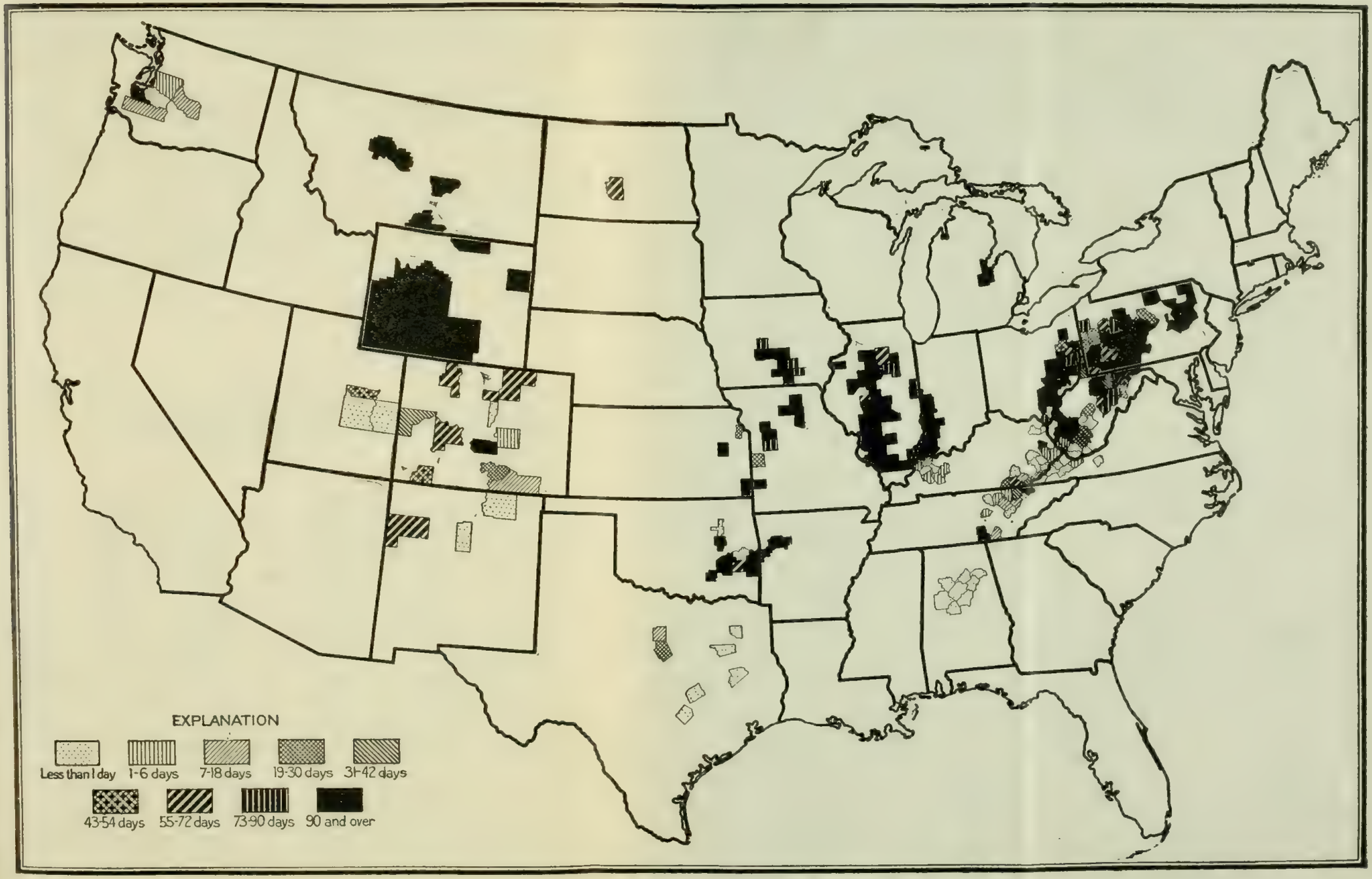
In the nonunion fields and those debatable districts lying on the border of the undisputed union territory the record is not so clear. The typical mine in the nonunion district affected by the strike, after being completely closed for a time, was operated for a long period with less than the normal force. Men formerly employed at a mine continued on strike, even after the operator had induced enough men to return to work to enable him to open the mine and begin shipping coal. Such short-handed operation might continue for weeks or months before the working force was again filled up to normal. Now, this situation at typical nonunion mines could not be adequately described by answers to the questions on the Geological Survey's report cards. In answering the question as to the average number of days that the strike lasted, many operators gave the number of days that the mines were wholly shut down, rather than the average number of days that all the strikers, including those who returned to work early and those who stayed out to the end, were absent from the mines. This interpretation of the Survey's inquiry was a natural one, but it failed to show the true extent of the strike in curtailing the potential supply of coal, the point on which the Survey desired information. When, therefore, the report of a nonunion operator showed that the daily output of his mine, after resumption of work, was far below the normal output as indicated by his previous reports to the Survey, a correction was made in the reported length of time the strikers were out.

Other uncertainties attended the interpretation of the reports for the nonunion fields. It was often difficult for the operator to tell how many men were on strike. He was naturally reluctant to believe that all the men who remained away from work had affiliated themselves with the strikers, thinking that some of them, otherwise loyal to him, were restrained by fear. The Geological Survey seeking to ascertain the effectiveness of the strike in stopping production, would consider all men absent from work under circumstances clearly connected with the strike as absent on account of the strike and would include them in its statistics.

A further uncertainty arose when an operator brought in strike breakers or recruited a new force from some other district or mine. Though the men formerly employed continued to live in tent colonies seeking ultimately to get back their jobs, such an operator would cease to count them as his employees and therefore might not report them as strikers. Because of these and other uncertainties, it was necessary to examine with great care replies from the nonunion fields and to check them against every available piece of information from



On April 1, 1922, a ge ons or more, as indicated by the average number of days lost through strike t measures not only the areal extent of the strike but its intensity. In using ounty, Pa., for example, is a composite of what happened in certain recognize e county average is affected accordingly. In certain parts of the strongly org



STRENGTH OF THE UNITED MINE WORKERS IN THE STRIKE OF 1922.

On April 1, 1922, a general strike of coal-mine workers was called in which the nonunion miners were invited to join. The map shows the effect in each county producing 100,000 tons or more, as indicated by the average number of days lost through strikes per man employed. The map therefore shows not only the counties where the men struck, but also the approximate length of time they stayed out. It measures not only the areal extent of the strike but its intensity. In using the map certain qualifications must be kept in mind. Boundaries between union and nonunion fields in places cut the county lines. The average for Cambria County, Pa., for example, is a composite of what happened in certain recognized union strongholds and in other camps that long had been nonunion. In partly organized fields, like Colorado, some mines closed and others did not, and the county average is affected accordingly. In certain parts of the strongly organized fields stripping mines, or mines serving a purely local market, continued to operate, reducing the average number of days lost per man employed.

other sources. Changes in the original reports were made only when there was clear indication of a misunderstanding of the question by the operator. All this work of editing was supervised personally by the senior author of this report, and the results are presented as the most accurate measure of the extent of the great strike of 1922 that can ever be made. From the nature of the difficulties above outlined and the methods of editing employed, it is concluded that the figures understate rather than overstate the effectiveness of the strike in limiting output in the nonunion fields.

The figures for 1922 in the following table are intended to show the total number of men that responded to the strike call and the total number of days that they were in idleness. They therefore include men who continued on strike after the mines in which they were employed resumed operation with a subnormal force. The numbers shown are thus greater than the number of employees in those mines that were forced to close entirely.

Strikes and lockouts in the coal mines of the United States in 1921 and 1922.

State.	1921					1922				
	Total number of men employed.	Number of men on strike.	Man-days idle on account of strike.	Average number of days lost per man employed.	Average number of days lost per man on strike.	Total number of men employed.	Number of men on strike.	Man-days idle on account of strike.	Average number of days lost per man employed.	Average number of days lost per man on strike.
Alabama	25,809	2,329	157,401	6	68	28,169	46	167	[a]	4
Arkansas	3,616	1,677	17,400	5	10	4,035	3,691	435,507	108	118
Colorado	14,529	2,497	72,830	5	29	13,506	6,672	527,250	39	79
Illinois	95,431	18,088	226,112	2	13	96,336	93,584	11,547,829	120	123
Indiana	32,687	17,634	321,593	10	18	33,208	31,721	3,924,396	118	124
Iowa	11,386	897	1,840	[a]	2	12,857	12,192	1,479,497	115	121
Kansas	8,207	7,285	538,811	66	74	7,359	6,515	847,075	115	130
Kentucky	50,521	1,789	64,448	1	36	60,924	10,270	605,441	10	59
Maryland	4,668	123	4,463	1	36	3,755	4,446	688,206	183	155
Michigan	2,212	780	2,826	1	4	2,166	2,062	247,919	114	120
Missouri	8,555	2,089	50,108	6	24	8,750	7,535	939,192	107	125
Montana	4,178	92	2,035	[a]	22	3,635	3,361	428,678	118	128
New Mexico	4,577	425	1,700	[a]	4	4,001	585	75,135	19	128
North Dakota	1,064	15	225	[a]	15	1,648	578	49,238	30	85
Ohio	51,785	17,682	176,605	3	10	54,194	46,283	5,502,885	102	118
Oklahoma	8,854	1,520	12,231	1	8	7,828	5,872	773,127	99	132
Pennsylvania (bituminous)	190,643	14,895	302,525	2	20	188,838	155,604	18,388,895	97	118
Tennessee	10,347	638	17,350	2	27	11,449	5,864	482,231	42	82
Texas						2,841	693	13,867	5	20
Utah	4,422	100	200	[a]	2	4,721	2,111	212,896	45	101
Virginia						13,399	240	2,200	[a]	9
Washington	4,334	802	139,126	32	173	4,481	2,225	299,861	67	135
West Virginia	101,850	7,198	170,017	2	24	110,014	49,832	5,348,298	49	107
Wyoming	8,484	591	2,978	[a]	5	9,045	8,607	1,054,227	117	122
Total bituminous	648,159	99,146	2,282,824	4	23	687,159	460,589	53,874,017	78	117
Pennsylvania anthracite	159,499	52,117	823,279	5	16	156,849	142,442	19,623,026	125	138
Grand total	807,658	151,263	3,106,103	4	21	844,008	603,031	73,497,043	87	122

[a] Less than half a day.

MAXIMUM EXTENT OF STRIKE IN EACH DISTRICT.

Totals for entire States, such as are given in the preceding table, do not distinguish between the condition in union and nonunion districts lying within the same State. To supply such information, the following table is presented. It shows the maximum extent to which the productive power of each district was curtailed during the strike of 1922. The figures are based in part upon the weekly reports of production and running time furnished by operators of about 3,000 mines to the Geological Survey. They have been supplemented by the annual reports received from all operators. The figures represent, not the percentage of the mines closed down by the strike, but rather the percentage of the miners that were absent from work, and therefore show the part of the normal producing power of the district shut off by the strike. Thus the table does not mean that 81 per cent of the mines or coke ovens in the Connellsville district were thrown idle by the strike, for, in fact, a very large number of plants continued to operate with depleted forces. It means rather that something like 81 per cent of the number of employees in the district were absent from work at the moment of maximum effectiveness of the strike, and that the potential shipments at that moment were therefore cut to something like 15 per cent of what had been possible before.

In using this table it is essential to bear in mind that the percentage for each district represents the condition at the moment of maximum intensity of the strike in that district. In many fields the strike was 100 per cent effective for nearly five months. In others the men were out only for a few weeks. In still others there was a gradual drift back to work extending over months. Furthermore, the moment of maximum stoppage did not come in all fields at the same time. The strike was over in Texas before it reached its height in the nonunion fields. For this reason the shutdown was never quite as complete over the country as a whole as the percentages in the table would indicate.

At one time or another about 73 per cent of the productive capacity of the bituminous-coal industry was rendered idle—slightly more even than during the great strike of 1919, for although the union in the meantime had lost ground in certain districts, notably Colorado, New River, southeastern Kentucky, Tennessee, and Alabama, its losses in these directions were more than offset by the walkout of the nonunion men in Pennsylvania.

Maximum extent to which the productive capacity of the several bituminous-coal districts was curtailed at any time during the great strike of 1922, with the production of each district in 1918.

District.	Maximum percentage of district capacity closed during 1922 strike.	District production in 1918 (net tons).	Product of columns 1 and 2.
Central Pennsylvania	92	61,629,000	56,699,000
Northwestern Pennsylvania	[a] 67	8,051,000	5,394,000
Pittsburgh, Pennsylvania	[b] 95	48,299,000	45,884,000
West Virginia Panhandle	44	3,255,000	1,432,000
Westmoreland, Latrobe, Greensburg, and Ligonier	[a] 65	17,701,000	11,506,000
Connellsville	[a] 81	35,677,000	28,898,000
Somerset	[a] 88	7,194,000	6,331,000
Cumberland-Piedmont	85	7,073,000	6,012,000
Fairmont, West Virginia[d]	87	20,104,000	17,490,000
Northern Ohio	95	30,287,000	28,773,000
Michigan	100	1,465,000	1,465,000
Southern Ohio	[b] 100	15,768,000	15,768,000
Northeastern Kentucky	8	7,109,000	568,000
Hazard, Kentucky		2,364,000	
Kanawha[e]	90	13,324,000	11,992,000
Kenova-Thacker	[c]	7,024,000	35,000
Logan		10,307,000	
New River	[a] 58	9,292,000	5,389,000
Winding Gulf	[a] 15	5,156,000	773,000
Pocahontas and Tug River	[c]	23,128,000	116,000
Southwestern Virginia		9,041,000	
Southern Appalachian[f]	57	11,712,000	6,676,000
Harlan	21	3,202,000	672,000
Alabama and Georgia		19,252,000	
Western Kentucky	7	10,833,000	758,000
Indiana	[b] 100	30,679,000	30,679,000
Illinois	[b] 100	89,291,000	89,291,000
Iowa	100	8,192,000	8,192,000
Missouri	93	5,668,000	5,271,000
Kansas	94	7,562,000	7,108,000
Arkansas	96	2,227,000	2,138,000
Oklahoma	79	4,813,000	3,802,000
Texas	25	2,261,000	565,000
North Dakota	37	720,000	266,000
Montana	98	4,533,000	4,442,000
Colorado	53	12,408,000	6,576,000
Utah	45	5,137,000	2,312,000
New Mexico	15	4,023,000	603,000
Washington	50	4,082,000	2,041,000
Wyoming	100	9,438,000	9,438,000
Average	[g] 73.3	[h] 579,281,000	425,355,000

[a] Partly estimated.
[b] Certain stripping pits and mines serving purely local trade continued to operate.
[c] Less than half of 1 per cent.
[d] Includes all of northern West Virginia except the Panhandle and Cumberland-Piedmont districts.
[e] Includes all high-volatile coal produced in southern West Virginia except that in the New River, Logan, and Kenova-Thacker districts.
[f] Includes Tennessee and all of southeastern Kentucky except Harlan County.
[g] Because the moment of maximum effectiveness did not come in all districts at the same time, the shutdown over the country as a whole was never quite as great as is here indicated.
[h] Exclusive of production in Alaska, California, Idaho, North Carolina, Oregon, and South Dakota.

PRODUCTION CLASSIFIED BY MINING METHODS.

EXPLANATION OF TERMS.

The term "mining method" as used in the following tables refers to the manner in which the coal is broken down in the mine and not to the system of mining, as by room and pillar or long wall. Coal in the mine is either blasted from a solid face—"shot from the solid"—as in hard-rock mining, or is shot loose or otherwise broken down after a cut has been made in the bed. This cut may be made either by hand or by machine. Underground methods are therefore classified as shooting from the solid, mining by hand, and mining by

machine. An increased quantity of coal is being recovered from stripping operations in which the overburden is stripped from the bed in open pits by steam shovels. The bed thus exposed is generally shattered by powder, and the coal is shoveled into cars by hand or steam shovels.

Opposition to the practice of shooting from the solid has grown in recent years, because this practice injures the mining property and creates dangerous conditions in the mines. The heavy charges of powder weaken the roof and pillars and thus increase the danger of falls of roof and coal, the most prolific source of fatal accidents to coal miners. Another objection to this method, based upon commercial rather than humanitarian considerations, is that the heavy charges of explosives required to blow down coal that has not been undercut or sheared produce a much higher proportion of fine or small coal and make the lump coal so friable that it disintegrates in handling and in transportation. The growing use of mechanical stokers and the developments made in the use of powdered coal have robbed this objection of much of its force, but the danger to the mine and to the workers still continues, and in some States shooting from the solid is forbidden by law.

SUMMARY OF PERCENTAGES FOR 1921 AND 1922.

The percentage of coal recovered by the use of machines, which had been increasing steadily in recent years, received a slight setback in 1922. In 1918, the year of the maximum production of bituminous coal, the percentage mined by machine was 55.9; in 1919 it rose to 59.2; in 1920 to 59.8; and in 1921 to 65.6 per cent. In 1922, however, it dropped to 63.2 per cent. This decrease was due to the strike, rather than to a permanent check in the growth of machine mining. The total quantity of machine-mined coal in 1922 was 5,669,458 tons less than the total in 1921, but the decrease in the four States comprising the central competitive field was 23,650,910 tons. Of the 25 coal-producing States included in the following tables 13 showed increases in the percentage of production mined by machine in 1922.

The output for which the mining method is not specified in the following tables was made mainly at small operations, and most of it was probably shot from the solid.

Bituminous coal mined by different methods in 1921.

State.	Mined by hand.		Shot off the solid.		Mined by machines.		From strip pits.		Not specified.		Total production (net tons).
	Net tons.	Percentage.	Net tons.	Percentage.	Net tons.	Percentage.	Net tons.	Percentage.	Net tons.	Percentage.	
Alabama	2,197,394	17.5	4,973,545	39.6	5,012,152	39.9	342,033	2.7	43,775	0.3	12,568,899
Arkansas	21,827	1.8	1,036,582	84.4	159,591	13.0	3,350	.3	6,427	.5	1,227,777
Colorado	4,403,048	48.2	475,553	5.2	4,182,342	45.8			76,686	.8	9,137,629
Georgia			23,252	68.8			10,563	31.2			33,815
Illinois	3,833,728	5.5	19,473,525	28.0	45,609,876	65.5	586,203	.8	99,431	.2	69,602,763
Indiana	1,484,360	7.3	7,246,546	35.7	10,737,554	52.8	800,738	3.9	50,311	.3	20,319,509
Iowa	572,754	12.7	3,227,867	71.2	698,443	15.4			32,328	.7	4,531,392
Kansas	258,956	7.5	2,772,340	80.0	34,269	1.0	367,207	10.6	33,869	.9	3,466,641
Kentucky	1,565,959	5.0	3,289,743	10.4	26,509,773	83.9	134,729	.4	88,066	.3	31,588,270
Maryland	1,526,022	83.5	113,578	6.2	186,165	10.2			1,975	.1	1,827,740
Michigan	10,000	.9	40,260	3.5	1,091,455	95.6					1,141,715
Missouri	453,440	12.8	1,215,841	34.2	1,063,127	29.9	782,243	22.0	36,970	1.1	3,551,621
Montana	666,451	24.4	947,714	34.7	1,106,567	40.5			13,226	.4	2,733,958
New Mexico	1,614,718	65.7	84,381	3.4	743,864	30.3			13,979	.6	2,456,942
North Dakota	37,243	4.3	328,946	38.0	336,848	39.0	122,889	14.2	38,977	4.5	864,903
Ohio	852,590	2.7	387,583	1.2	29,256,048	91.6	1,260,815	3.9	185,740	.6	31,942,776
Oklahoma	21,184	.6	1,189,953	35.4	1,908,959	56.8	230,059	6.8	12,468	.4	3,362,623
Pennsylvania (bituminous)	38,401,118	33.1	2,185,598	1.9	73,842,026	63.6	488,253	.4	1,096,947	1.0	116,013,942
Tennessee	1,409,752	31.6	1,789,562	40.1	1,239,611	27.8	2,406	.1	18,995	.4	4,460,326
Texas	656,848	67.5	271,251	27.9	44,740	4.6					972,839
Utah	870,982	21.3	137,220	3.4	3,070,582	75.1			11,611	.2	4,090,395
Virginia	229,507	3.1	1,421,176	19.0	5,841,695	77.9					7,492,378
Washington	1,171,434	48.2	1,041,112	42.9	131,566	5.4			84,610	3.5	2,428,722
West Virginia	14,835,874	20.4	1,532,828	2.1	56,163,635	77.2	6,000		248,659	.3	72,786,996
Wyoming	967,324	13.4	2,433,519	33.8	3,731,501	51.8	68,322	1.0			=7,200,666
Other States	55,138	37.6	83,962	57.3					7,553	5.1	146,653
	78,117,651	18.8	57,723,437	13.9	272,702,389	65.6	5,205,810	1.2	2,202,603	.5	415,951,890

Bituminous coal mined by different methods in 1922.

State.	Mined by hand.		Shot off the solid.		Mined by machines.		From strip pits.		Not specified		Total production (net tons).
	Net tons.	Percentage.	Net tons.	Percentage.	Net tons.	Percentage.	Net tons.	Percentage	Net tons.	Percentage.	
Alabama	3,654,253	19.9	6,907,192	37.7	7,265,408	39.7	375,166	2.0	122,721	0.7	18,324,740
Arkansas	42,307	3.8	798,440	71.9	171,426	15.5	39,761	3.6	58,112	5.2	1,110,046
Colorado	4,217,871	42.1	617,786	6.2	5,051,340	50.4	2,700		129,900	1.3	10,019,597
Georgia			20,600	34.0			40,036	66.0			60,636
Illinois	3,152,543	5.4	15,257,280	26.1	38,952,697	66.6	720,060	1.2	385,156	.7	58,467,736
Indiana	1,258,355	6.6	6,694,581	35.0	9,539,004	49.8	1,374,715	7.2	266,234	1.4	19,132,889
Iowa	783,502	18.0	2,878,096	66.4	588,877	13.6			84,686	2.0	4,335,161
Kansas	116,183	3.9	2,136,119	72.3	95,152	3.2	404,947	13.7	202,769	6.9	2,955,170
Kentucky	1,766,963	4.2	5,355,037	12.7	33,322,271	79.1	468,845	1.1	1,221,059	2.9	42,134,175
Maryland	691,172	56.5	174,625	14.3	303,070	24.8			53,840	4.4	1,222,707
Michigan	500	.1	35,510	3.8	893,380	96.1					929,390
Missouri	355,821	12.1	756,672	25.9	871,466	29.8	833,427	28.5	107,364	3.7	2,924,750
Montana	564,489	21.9	532,244	20.7	1,433,602	55.8			41,886	1.6	2,572,221
New Mexico	1,589,120	50.5	529,068	16.8	986,417	31.3			42,568	1.4	3,147,173
North Dakota	13,882	1.0	400,325	30.2	442,436	33.3	274,722	20.7	196,199	14.8	1,327,564
Ohio	753,100	2.8	675,978	2.5	21,683,670	80.5	3,156,615	11.7	684,428	2.5	26,953,791
Oklahoma	15,397	.5	1,008,307	36.0	1,398,535	49.9	321,580	11.5	58,692	2.1	2,802,511
Pennsylvania (bituminous)	37,894,142	33.5	4,213,465	3.7	65,619,223	58.0	1,951,316	1.7	3,470,162	3.1	113,148,308
Tennessee	665,757	13.6	2,661,860	54.6	1,435,530	29.5	6,411	.1	107,216	2.2	4,876,774
Texas	755,378	68.3	284,412	25.7	47,217	4.3			19,000	1.7	1,106,007
Utah	973,697	19.5	200,824	4.0	3,816,537	76.5			950		4,992,008
Virginia	511,515	4.9	2,371,657	22.6	7,541,631	71.9			66,371	.6	10,491,174
Washington	1,179,153	45.7	1,032,724	40.0	330,141	12.8			39,147	1.5	2,581,165
West Virginia	15,335,166	19.1	2,650,315	3.3	61,763,445	76.7	179,841	.2	559,425	.7	80,488,192
Wyoming	900,866	15.1	1,530,316	25.6	3,451,956	57.8	75,000	1.3	13,586	.2	5,971,724
Other States	53,107	27.6	103,111	53.6	28,500	14.8			7,772	4.0	192,490
	77,244,239	18.3	59,826,544	14.2	267,032,931	63.2	10,225,142	2.4	7,939,243	1.9	422,268,099

PRODUCTION BY MINING MACHINES.

The total quantity of bituminous coal mined by machines in 1922 was 267,032,931 tons, as against 272,702,389 tons in 1921. In individual States decreases in the percentage of the total output mined by machines were shown in Alabama, 0.2 per cent; Indiana,3; Iowa, 1.8; Kentucky, 4.8; Missouri, 0.1; North Dakota, 5.7; Ohio, 11.1; Oklahoma, 6.9; Pennsylvania, 5.6; Texas, 0.3; Virginia, 6; West Virginia, 0.5. Increases were shown in Arkansas, 2.5 per cent; Colorado, 4.6; Illinois, 6.6; Kansas, 2.2; Maryland, 14.6; Michigan, 0.5; Montana, 15.3; New Mexico, 1; North Carolina, 14.8; Tennessee, 1.7; Utah, 1.4; Washington, 7.4; Wyoming, 6.

Further support for the statement that the decline in the percentage of coal recovered by machine mining was a temporary loss due to the strike is found in the statistics covering the total number of machines in use in the two years under review. The total number reported in 1922 was 20,436, as compared with 19,618 in 1921—a net gain of 818 machines. Of the 25 coal-producing States 15 reported a larger number of machines in use in 1922 than in 1921. There were, however, 170 fewer machines in use in Indiana, Iowa, Maryland, Michigan, Missouri, Montana, Oklahoma, Texas, Washington, and Wyoming. One-third of this total decrease was in Indiana, where the number of machines in use dropped from 856 to 797; Montana was second, with a loss of 42 machines; Washington used 30 less; Oklahoma, 17; Iowa, 7; Wyoming, 5; Maryland, 4; and Michigan, Missouri, and Texas, 2 each. The average output per machine in 1922 was only 13,067 tons, as compared with 13,901 tons in 1921 and 17,788 tons in 1920. The average for 1922 was the lowest since 1914, because of the small number of days worked.

The quantity of anthracite mined in Pennsylvania by machine decreased from 874,237 gross tons in 1921 to 448,922 gross tons in 1922. This heavy loss, of course, was due to the strike. Nevertheless, there has been a sharp decline in the tonnage mined by machine in the anthracite regions since 1919, when 1,406,433 gross tons was so produced, and even that figure was lower than the totals for the three years preceding.

Bituminious coal mined by machines in the United States, 1921 and 1922.

State.	Machines in use.		Quantity mined by machines (net tons).		Percentage of total product mined by machines.	
	1921	1922	1921	1922	1921	1922
Alabama	310	355	5,012,152	7,265,408	39.9	39.7
Arkansas	26	45	159,591	171,426	13.0	15.5
Colorado	439	455	4,182,342	5,051,340	45.8	50.4
Illinois	2,769	2,841	45,609,876	38,952,697	65.5	66.6
Indiana	856	797	10,737,554	9,539,004	52.8	49.8
Iowa	98	91	698,443	588,877	15.4	13.6
Kansas	8	17	34,269	95,152	1.0	3.2
Kentucky	1,759	1,784	26,509,773	33,322,271	83.9	79.1
Maryland	35	31	186,165	303,070	10.2	24.8
Michigan	90	88	1,091,455	893,380	95.6	96.1
Missouri	134	132	1,063,127	871,466	29.9	29.8
Montana	126	84	1,106,567	1,433,602	40.5	55.8
New Mexico	99	107	743,864	986,417	30.3	31.3
North Carolina		1		28,500		14.8
North Dakota	17	20	336,848	442,436	39.0	33.3
Ohio	2,149	2,342	29,256,048	21,683,670	91.6	80.5
Oklahoma	224	207	1,908,959	1,398,535	56.8	49.9
Pennsylvania	6,332	6,337	73,842,026	65,619,223	63.6	58.0
Tennessee	176	180	1,239,611	1,435,530	27.8	29.5
Texas	6	4	44,740	47,217	4.6	4.3
Utah	182	183	3,070,582	3,816,537	75.1	76.5
Virginia	257	264	5,841,695	7,541,631	77.9	71.9
Washington	57	27	131,566	330,141	5.4	12.8
West Virginia	3,229	3,809	56,163,635	61,763,445	77.2	76.7
Wyoming	240	235	3,731,501	3,451,956	51.8	57.8
	19,618	20,436	272,702,389	267,032,931	[a] 65.6	[a] 63.2

[a] Average.

Bituminous coal mined by machines in the United States, 1891–1922.

Year.	Machines in use.	Quantity mined by machine (net tons).		Year.	Machines in use.	Quantity mined by machine (net tons).	
		Total.	Average per machine.			Total.	Average per machine.
1891	545	6,211,732	11,398	1909	13,049	142,496,878	10,920
1896	1,446	16,424,932	11,373	1910	13,254	174,012,293	13,127
1897	1,956	22,649,220	11,579	1911	13,829	178,158,236	12,854
1898	2,622	32,413,144	12,362	1912	15,298	210,538,822	13,763
1899	3,125	43,963,933	14,068	1913	16,379	242,421,713	14,801
1900	3,907	52,784,523	13,510	1914	16,507	218,399,287	13,231
1901	4,341	57,843,335	13,325	1915	15,692	243,237,551	15,501
1902	5,418	69,611,582	12,848	1916	16,198	283,691,475	17,514
1903	6,658	77,974,894	11,712	1917	17,235	306,396,127	17,777
1904	7,663	78,606,997	10,258	1918	18,463	323,931,133	17,545
1905	9,184	103,396,452	11,258	1919	18,959	276,019,799	14,559
1906	10,212	118,847,527	11,638	1920	19,103	339,813,476	17,788
1907	11,144	138,547,823	12,432	1921	19,618	272,702,389	13,901
1908	11,569	123,183,334	10,648	1922	20,436	267,032,931	13,067

Anthracite (Pennsylvania) mined by machines, 1916–1922.

Year.	Gross tons.	Year.	Gross tons.
1916	1,642,416	1920	837,565
1917	1,745,735	1921	874,237
1918	1,658,495	1922	448,922
1919	1,406,433		

PRODUCTION FROM STEAM-SHOVEL PITS.

A new record for the output of bituminous coal mined by steam shovels was made in 1922, when the quantity so recovered reached 9,886,431 tons, as compared with 4,699,511 tons in 1921 and 8,859,553 tons in 1920. The number of shovels in operation—379—was also the largest in the history of the industry, exceeding the number reported for the preceding year by 100 and the earlier record established in 1920 by 67. No new States entered the list of strip-pit producers in 1922. There were 4 shovels less in operation in Kansas in 1922 than in 1921, 5 less in Missouri, and 1 less in Tennessee. On the other hand, there was an increase of 55 in the number of shovels in use in Pennsylvania and 25 in Ohio, with smaller increases in Arkansas, Illinois, Indiana, Kentucky, North Dakota, Oklahoma and West Virginia. Ohio, which held first place in tonnage in 1921 by a margin of less than 42,000 tons, increased its shovel output from 835,836 to 3,055,844 tons. Pennsylvania, which ranked fifth in tonnage in 1921, jumped into second place in 1922, when its output increased from 482,759 to 1,895,490 tons. Indiana slipped from second to third place but increased its output from 793,604 to 1,366,015 tons. All other States working steam shovels also reported increases, the most remarkable measured in percentage being Arkansas, from 700 to 27,347 tons, and West Virginia, from 6,000 to 174,225 tons.

The future of the steam shovel in bituminous-coal mining is one of the most interesting questions now confronting the industry. In 1918 the quantity of bituminous coal recovered from the strip pits approximated 1.4 per cent of the total production that year; in 1919 it was 1.2 per cent; in 1920 it was 1.6 per cent; in 1921 it dropped back to 1.2 per cent; and in 1922 it rose to 2.4 per cent. In the years of depression—1919 and 1921—the pit operations have not been able to hold their share of the available business, but in the years of better demand they have pushed ahead at a faster rate. From this it might be argued that stripping is a "wild-cat" operation which can succeed only when industrial booms or strike losses at mines of other types create a demand that makes no fine distinctions in quality and preparation. Such an argument will hardly hold in the face of the growth of stripping operations in the States east of Mississippi River.

The much lower cost per ton at which strip-pit coal can be mined gives the steam-shovel operation a marked initial advantage over the shaft or slope mine at times when the struggle for business becomes a penny-shaving fight. The nature of the work and the physical conditions that must be met are of course limitations upon the growth of the recovery of coal by stripping. The advantage above mentioned, however, is giving an impetus to this type of mining where the overburden makes it mechanically feasible and the coal to be recovered has the physical structure and the chemical composition to warrant competitive marketing.

The number of shovels reported in use in the Pennsylvania anthracite region dropped from 85 in 1921 to 69 in 1922, and the recovery from strip pits from 2,027,790 to 949,745 net tons. In 1916 there were 105 shovels in use and the production was 1,987,800 net tons. In 1918, with 82 shovels in use, the output reached 2,360,183 net tons—a total that has not been exceeded since that time.

Coal recovered from steam-shovel strip pits in 1921 and 1922.

State.	1921		1922	
	Number of shovels.	Coal mined (net tons).	Number of shovels.	Coal mined (net tons).
Alabama	15	340,120	15	368,820
Arkansas	1	700	3	27,347
Georgia	1	10,563		
Illinois	22	564,168	23	706,360
Indiana	38	793,604	50	1,366,015
Kansas	23	364,479	19	389,996
Kentucky	5	134,729	15	468,845
Missouri	37	780,006	32	833,147
North Dakota	3	86,419	5	198,851
Ohio	83	835,836	108	3,055,844
Oklahoma	13	229,400	14	320,080
Pennsylvania	28	482,759	83	1,895,490
Tennessee	2	2,406	1	6,411
West Virginia	5	6,000	8	174,225
Wyoming	3	68,322	3	75,000
Total bituminous	279	4,699,511	379	9,886,431
Pennsylvania anthracite	85	2,027,790	69	949,745
Grand total	364	6,727,301	448	10,836,176

Coal recovered from steam-shovel strip pits in the United States, 1914–1922.

Year.	Pennsylvania anthracite.		Bituminous coal.		Total.	
	Number of shovels.	Coal mined (net tons).	Number of shovels.	Coal mined (net tons).	Number of shovels.	Coal mined (net tons).
1914	(a)	(a)	48	1,280,946	48	1,280,946
1915	57	1,121,603	87	2,831,619	144	3,953,222
1916	105	1,987,800	111	3,933,395	216	5,921,195
1917	76	2,301,588	182	5,789,977	258	8,091,565
1918	82	2,360,183	276	8,288,245	358	10,648,428
1919	89	2,006,879	287	5,634,951	376	7,641,830
1920	96	2,054,441	312	8,859,553	408	10,915,994
1921	85	2,027,790	279	4,699,511	364	6,727,301
1922	69	949,745	379	9,886,431	448	10,836,176

[a] Not available.

COAL-WASHING OPERATIONS.

No canvass covering coal-washing operations in 1922 was made by the Geological Survey. In 1921 the total coal washed was 15,355,169 tons and the quantity recovered was 13,628,724 tons—about 88.7 per cent. During the 16 years for which data are available the total quantity of coal washed ranged from 10,425,455 tons, with an 88.5 per cent recovery, in 1906, to 28,587,137 tons, with an 89.1 per cent recovery, in 1917.

Bituminous coal washed at the mines in the United States, 1906–1921.[a]

Year.	Coal washed (net tons).	Cleaned coal (net tons).	Refuse (net tons)	Percentage of cleaned coal to total output
1906	10,425,455	9,251,946	1,173,509	2.7
1907	12,981,514	11,269,518	1,711,996	2.9
1908	13,660,478	11,870,438	1,790,040	3.6
1909	16,541,874	14,443,147	2,098,727	3.8
1910	18,395,382	16,035,387	2,359,995	3.8
1911	12,355,716	10,830,823	1,524,893	2.7
1912	19,844,517	17,538,572	2,305,945	3.9
1913	25,051,801	22,069,691	2,982,110	4.6
1914	22,848,647	20,264,141	2,584,506	4.8
1915	23,472,036	20,873,727	2,598,309	4.7
1916	25,632,974	22,922,218	2,710,756	4.6
1917	28,587,137	25,483,696	3,103,441	4.6
1918	25,119,548	22,017,293	3,102,255	3.8
1919	19,187,837	16,884,062	2,303,775	3.6
1920	20,595,750	17,984,289	2,611,461	3.2
1921	15,355,169	13,628,724	1,726,445	3.3

[a] Canvass not made for 1922.

NUMBER AND SIZE OF MINES.

CLASSES OF MINES, BY OUTPUT.

In discussing the number of mines distinction must be made between commercial mines and the small workings known as "wagon mines," "snowbirds," and "country banks." The line between the commercial mine and the small working, however, is difficult to draw. Mere size of output is not a criterion, for some wagon mines ship rather large quantities of coal. Absence of a railroad switch is not a criterion, for this would exclude from the commercial class some large mines that ship by river or truck or that deliver their product to associated industries at the mouth of the mine.

In practice the Geological Survey has found a safer criterion to be size in conjunction with steady operation. All mines that produce 10,000 tons or more a year are classed by the Survey as "commercial mines," but the commercial class also includes much smaller mines, some of which have an annual output of 1,000 tons or less but produce year after year and show a fairly continuous existence.

Workings still smaller or less continuous in operation have been classed by the Survey as "small mines." The term is not satisfactory, however, because it is not sufficiently definite, and in the present report these workings are generally called "wagon mines," the term that in common usage most nearly describes them. A mine may be shifted from the list of commercial mines to the list of wagon mines or vice versa, as the course of the work at the mine may make such a shift advisable.

In the first of the following tables the wagon mines have been excluded, because the record of the number of such mines does not begin until 1913. In certain of the succeeding tables (pp. 533, 534) the record is given in detail for all workings, large and small, for which the Geological Survey received information.

For convenience in studying production by size of mines, the Survey divides the mines into five classes. Class 1 includes mines

that produce each year more than 200,000 tons; class 2, those that produce less than 200,000 and more than 100,000 tons; class 3, those that produce less than 100,000 and more than 50,000 tons; class 4, those that produce less than 50,000 and more than 10,000 tons; and class 5, those that produce less than 10,000 tons. As this classification is made according to performance, not according to capacity, the number of mines in a given class is not constant from year to year. In 1918, for example, 821 mines were listed in class 1; in 1919, 550; in 1920, 701; in 1921, 482; and in 1922, 416. These fluctuations do not indicate a corresponding change from year to year in the number of mines having the acreage and the development that would enable them to produce annually 200,000 tons or more, but they do indicate that in a given year only the number of mines listed in class 1 were able to market more than 200,000 tons.

During periods of business depression the production of the coal mines of the country as a whole is limited by the condition of industry in general. Many mines in class 1 that can market 200,000 tons or more in a favorable year are able to market much less in an unfavorable year; many mines in class 2 slip back into class 3, and so on down the line, until most of the smaller mines probably drop out altogether or produce so little that their effect upon the industry may be ignored. In a year such as 1922, in which a prolonged strike hits producing fields where individual mine development has been carried to a high point, inability to produce rather than inability to market will reduce the number of class 1 mines and increase the number in the lower classes.

This shifting in the number of mines in a given class under varying marketing conditions is illustrated in the next table below. In 1920, as compared with 1919, there was an increase of 151 in mines of class 1, of 177 in class 2, of 98 in class 3, and of 376 in class 4—a total increase of 802. The number of commercial mines in class 5, however, decreased. In 1919 mines of class 5 produced 2.8 per cent of the total output of all commercial mines; in 1920, only 1.9 per cent. In 1922, as compared with 1921, there was a decrease of 66 in the number of class 1 mines, but every other class showed an increase—class 2, 41; class 3, 81; class 4, 793; and class 5, 412.

In every year a number of mines cease operations, either temporarily or permanently. Old mines become exhausted and are abandoned. In times of poor demand the high cost of recovering coal forces some mines to close down, and others suspend because of financial difficulties, until conditions become more favorable or new owners take over the properties. It is a fair conclusion, however, that the percentage of suspension is higher in the smaller mines. Bituminous mines that can hoist 3,000 to 5,000 tons of coal in an 8-hour day are no longer a novelty. The owners of such a mine would not incur the cost of development to such a capacity and the expense of building up a sales organization equal to the task of marketing so much coal without providing a sufficient reserve area of coal land to give the mine a long life.

Number and yearly output of bituminous-coal mines, by size classes, 1905–1922.[a]

[Exclusive of wagon mines.]

Year.	Class 1 (more than 200,000 tons).	Class 2 (100,000 to 200,000 tons).	Class 3 (50,000 to 100,000 tons).	Class 4 (10,000 to 50,000 tons).	Class 5 (less than 10,000 tons).	Total.
Number of mines:						
1905	411	612	808	1,514	1,715	5,060
1910	618	763	960	1,568	1,909	5,818
1913	694	837	959	1,558	1,728	5,776
1917	792	914	1,044	1,996	2,193	6,939
1918	821	929	1,198	2,636	2,735	8,319
1919	550	854	1,181	2,784	3,625	8,994
1920	701	1,031	1,279	3,160	2,750	8,921
1921	482	807	1,003	2,346	3,400	8,038
1922	416	848	1,084	3,139	3,812	9,299
Net tons produced:						
1905	126,499,000	85,920,000	57,386,000	38,995,000	6,034,000	314,834,000
1910	191,519,000	107,052,000	68,858,000	42,282,000	6,561,000	416,272,000
1913	241,463,000	118,476,000	69,018,000	42,292,000	6,280,000	477,529,000
1917	285,366,000	129,486,000	74,894,000	51,596,000	8,824,000	550,166,000
1918	281,267,000	131,027,000	87,143,000	67,453,000	11,387,000	578,277,000
1919	174,848,000	120,926,000	84,625,000	71,334,000	13,198,000	464,931,000
1920	237,468,000	142,750,000	90,669,000	82,129,000	10,716,000	563,732,000
1921	162,438,000	115,607,000	71,160,000	56,099,000	10,618,000	415,922,000
1922	131,876,000	117,195,000	77,287,000	77,203,000	15,248,000	418,809,000
Percentage of total number of mines:						
1905	8.1	12.1	16.0	29.9	33.9	100.0
1910	10.6	13.1	16.5	27.0	32.8	100.0
1913	12.0	14.5	16.6	27.0	29.9	100.0
1917	11.4	13.2	15.0	28.8	31.6	100.0
1918	9.8	11.2	14.4	31.7	32.9	100.0
1919	6.1	9.5	13.1	31.0	40.3	100.0
1920	7.9	11.6	14.3	35.4	30.8	100.0
1921	6.0	10.0	12.5	29.2	42.3	100.0
1922	4.5	9.1	11.7	33.7	41.0	100.0
Percentage of total tonnage:						
1905	40.2	27.3	18.2	12.4	1.9	100.0
1910	46.0	25.7	16.5	10.2	1.6	100.0
1913	50.6	24.8	14.4	8.9	1.3	100.0
1917	51.9	23.5	13.6	9.4	1.6	100.0
1918	48.6	22.7	15.1	11.6	2.0	100.0
1919	37.6	26.0	18.2	15.4	2.8	100.0
1920	42.1	25.3	16.1	14.6	1.9	100.0
1921	39.1	27.8	17.1	13.5	2.5	100.0
1022	31.5	28.0	18.5	18.4	3.6	100.0

[a] This table shows mines, not companies, and should not be confused with other tables that include country banks and many wagon mines shipping by rail.

MINES IN 1922.

Alabama, Colorado, Kentucky, Utah, and Virginia were the only States to show a greater number of class 1 mines in 1922 than in 1921. The aggregate increase in these 5 States was 29. There was no change in the number of class 1 mines in New Mexico, North Dakota, and Tennessee. The loss in the rest of the States was 95, making the net decrease in class 1 mines 66. Illinois again led in total tonnage and the percentage of State output coming from class 1 mines. Pennsylvania was second in tonnage and West Virginia third. Montana had the highest average output per class 1 mine—391,000 tons; Alabama was a close second, with an average output of 381,834 tons. In considering the average output per mine weight must be given to the number of days worked; in Illinois, for example, the average number of days the mines (all classes) operated in 1922 was 120; Montana mines worked 140 days, and Alabama mines 215 days.

The average output of mines of class 1 throughout the United States was 317,010 tons. The output of mines of class 5 averaged 2,159 tons. This average includes the output of the wagon mines. Exclusive of wagon operations the average output of class 5 mines was 4,000 tons.

In comparing the following tables it should be noted that the wagon mines are not included in the figures for 1921, but are included in the figures for 1922.

Number and production of commercial bituminous-coal mines (exclusive of wagon mines) in the United States in 1921, by classes.

State.	Class 1 (more than 200,000 tons).					Class 2 (100,000 to 200,000 tons).					Class 3 (50,000 to 100,000 tons)				
	Mines.		Production.			Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.
Alabama	13	5.3	4,175,000	321,154	33.2	26	10.6	3,368,000	129,538	26.8	28	11.4	1,933,000	69,036	15.4
Arkansas						1	1.3	160,000	160,000	13.0	3	3.9	226,000	75,333	18.4
Colorado	7	3.3	1,869,000	267,000	20.5	24	11.3	3,322,000	138,417	36.4	32	15.0	2,249,000	70,281	24.7
Illinois	123	18.2	49,602,000	403,268	71.3	82	12.2	12,049,000	146,939	17.3	59	8.8	4,303,000	72,932	6.2
Indiana	29	10.5	9,048,000	312,000	44.5	42	15.2	5,880,000	140,000	28.9	47	17.0	3,370,000	71,702	16.6
Iowa	3	2.0	837,000	279,000	18.5	6	3.9	817,000	136,167	18.0	24	15.7	1,641,000	68,375	36.2
Kansas						4	2.9	473,000	118,250	13.7	20	14.6	1,336,000	66,800	38.5
Kentucky	18	2.6	6,400,000	355,556	20.3	80	11.6	11,124,000	139,050	35.2	110	15.9	7,690,000	69,909	24.3
Maryland						4	4.6	529,000	132,250	28.9	8	9.2	599,000	74,875	32.8
Michigan	1	7.1	261,000	261,000	22.9	5	35.7	595,000	119,000	52.1	1	7.1	64,000	64,000	5.6
Missouri						5	2.9	614,000	122,800	17.3	19	11.1	1,387,000	73,000	39.0
Montana	4	6.9	1,672,000	418,000	61.2	4	6.9	584,000	146,000	21.4	2	3.4	145,000	72,500	5.3
New Mexico	2	4.9	543,000	271,500	22.1	5	12.2	610,000	122,000	24.9	15	36.6	1,040,000	69,333	42.4
North Dakota	1	1.7	225,000	225,000	26.0						3	5.0	186,000	62,000	21.5
Ohio	40	4.9	12,277,000	306,925	38.4	68	8.3	9,713,000	142,838	30.4	66	8.0	4,671,000	70,773	14.6
Oklahoma						6	4.5	859,000	143,167	25.5	14	10.6	970,000	69,286	28.9
Pennsylvania	131	5.5	43,194,000	329,725	37.2	226	9.4	34,000,000	150,442	29.3	274	11.4	19,322,000	70,518	16.7
Tennessee	1	.7	292,000	292,000	6.5	11	7.7	1,502,000	136,545	33.7	14	9.8	917,000	65,500	20.6
Texas						1	2.8	104,000	104,000	10.7	4	11.1	224,000	56,000	23.0
Utah	8	22.2	2,374,000	296,750	58.2	8	22.2	1,278,000	159,750	31.3	4	11.1	315,000	78,750	7.7
Virginia	10	9.5	4,066,000	406,600	54.3	13	12.4	1,746,000	134,308	23.3	10	9.5	704,000	70,400	9.4
Washington	4	7.9	1,314,000	328,500	54.1	2	3.9	322,000	161,000	13.3	7	13.7	450,000	64,286	18.5
West Virginia	75	5.7	21,269,000	283,587	29.2	163	12.4	22,828,000	140,049	31.4	227	17.2	16,556,000	72,934	22.7
Wyoming	12	19.0	3,020,000	251,667	41.9	21	33.3	3,130,000	149,048	43.5	12	19.1	862,000	71,833	12.0
	482	6.0	162,438,000	337,008	39.1	807	10.0	115,607,000	143,255	27.8	1,003	12.5	71,160,000	70,947	17.1

Number and production of commercial bituminous-coal mines (exclusive of wagon mines) in the United States in 1921, by classes—Contd.

State.	Class 4 (10,000 to 50,000 tons).					Class 5 (less than 10,000 tons).					Total.		
	Mines.		Production.			Mines.		Production.			Mines.	Production (net tons).	
	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.		Total.	Average per mine.
Alabama	110	44.7	2,840,000	25,818	22.6	69	28.0	253,000	3,667	2.0	246	12,569,000	51,093
Arkansas	29	37.7	696,000	24,000	56.7	44	57.1	146,000	3,318	11.9	77	1,228,000	15,948
California, Idaho, Alaska, and Oregon	4	21.1	93,000	23,250	80.9	15	78.9	22,000	1,467	19.1	19	115,000	6,053
Colorado	63	29.6	1,471,000	23,349	16.1	87	40.8	212,000	2,437	2.3	213	9,123,000	42,831
Georgia	1	100.0	34,000	34,000	100.0						1	34,000	34,000
Illinois	116	17.3	2,867,000	24,716	4.1	292	43.5	782,000	2,678	1.1	672	69,603,000	103,576
Indiana	63	22.7	1,699,000	26,968	8.4	96	34.6	322,000	3,354	1.6	277	20,319,000	73,354
Iowa	45	29.4	979,000	21,756	21.6	75	49.0	257,000	3,427	5.7	153	4,531,000	29,614
Kansas	57	41.6	1,476,000	25,895	42.6	56	40.9	182,000	3,250	5.2	137	3,467,000	25,307
Kentucky	226	32.8	5,557,000	24,588	17.6	256	37.1	817,000	3,191	2.6	690	31,588,000	45,780
Maryland	25	28.7	556,000	22,240	30.4	50	57.5	144,000	2,880	7.9	87	1,828,000	21,011
Michigan	6	42.9	215,000	35,833	18.8	1	7.2	7,000	7,000	.6	14	1,142,000	81,571
Missouri	57	33.3	1,263,000	22,158	35.6	90	52.7	287,000	3,189	8.1	171	3,551,000	20,766
Montana	11	19.0	231,000	21,000	8.4	37	63.8	102,000	2,757	3.7	58	2,734,000	47,138
New Mexico	9	22.0	236,000	26,222	9.6	10	24.3	24,000	2,400	1.0	41	2,453,000	59,829
North Carolina	1	100.0	23,000	23,000	100.0						1	23,000	23,000
North Dakota	18	30.0	330,000	18,333	38.2	38	63.3	124,000	3,263	14.3	60	865,000	14,417
Ohio	182	22.1	3,981,000	21,874	12.5	466	56.7	1,301,000	2,792	4.1	822	31,943,000	38,860
Oklahoma	64	48.5	1,373,000	21,453	40.8	48	36.4	161,000	3,354	4.8	132	3,363,000	25,477
Pennsylvania	680	28.4	15,947,000	23,451	13.7	1,086	45.3	3,551,000	3,270	3.1	2,397	116,014,000	48,400
South Dakota						18	100.0	8,000	444	100.0	18	8,000	444
Tennessee	63	44.0	1,544,000	24,508	34.6	54	37.8	205,000	3,796	4.6	143	4,460,000	31,189
Texas	27	75.0	622,000	23,037	63.9	4	11.1	23,000	5,750	2.4	36	973,000	27,028
Utah	4	11.1	86,000	21,500	2.1	12	33.4	26,000	2,167	.7	36	4,079,000	113,306
Virginia	35	33.3	845,000	24,143	11.3	37	35.3	131,000	3,541	1.7	105	7,492,000	71,352
Washington	10	19.6	251,000	25,100	10.3	28	54.9	92,000	3,286	3.8	51	2,429,000	47,627
West Virginia	433	32.9	10,733,000	24,788	14.8	420	31.8	1,401,000	3,336	1.9	1,318	72,787,000	55,225
Wyoming	7	11.1	151,000	21,571	2.1	11	17.5	38,000	3,455	.5	63	7,201,000	114,302
	2,346	29.2	56,099,000	23,913	13.5	3,400	42.3	10,618,000	3,123	2.5	8,038	415,922,000	51,744

Number and production of bituminous-coal mines (including wagon mines) in the United States in 1922, by classes.

State.	Class 1 (more than 200,000 tons).					Class 2 (100,000 to 200,000 tons).					Class 3 (50,000 to 100,000 tons).				
	Mines.		Production.			Mines.		Production.			Mines.		Production.		
	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.	Number.	Per cent-age.	Total (net tons).	Average per mine (net tons).	Percentage.
Alabama	18	4.8	6,873,000	381,834	37.5	40	10.7	5,295,000	132,375	28.9	46	12.3	3,297,000	71,674	18.0
Alaska, California, Idaho, and Oregon															
Arkansas											3	2.3	190,000	63,333	17.1
Colorado	14	5.4	3,974,000	*283,857	39.7	16	6.2	2,158,000	134,875	21.5	28	10.8	1,960,000	70,000	19.6
Georgia											1	100.0	61,000	61,000	100.0
Illinois	103	13.5	36,725,000	356,553	62.8	91	11.9	12,716,000	139,736	21.7	69	9.0	5,082,000	73,652	8.7
Indiana	23	4.6	6,667,000	289,870	34.8	46	9.2	6,411,000	139,370	33.5	43	8.6	3,140,000	73,023	16.4
Iowa	2	.9	460,000	230,000	10.6	7	3.4	876,000	125,143	20.2	20	9.7	1,371,000	68,550	31.7
Kansas						2	.7	236,000	118,000	8.0	17	6.3	1,157,000	68,059	39.1
Kentucky	25	1.1	8,160,000	326,400	19.4	97	4.4	13,604,000	140,247	32.3	126	5.7	9,575,000	75,992	22.7
Maryland						1	.8	112,000	112,000	9.2	6	5.1	370,000	61,667	30.3
Michigan						2	15.4	346,000	173,000	37.2	6	46.2	458,000	76,333	49.3
Missouri						1	.5	188,000	188,000	6.4	15	6.8	1,028,000	68,533	35.1
Montana	3	4.5	1,173,000	391,000	45.6	4	6.1	612,000	153,000	23.8	6	9.1	454,000	75,667	17.6
New Mexico	2	3.5	625,000	312,500	19.9	17	29.8	1,976,000	116,235	62.8	6	10.5	387,000	64,500	12.3
North Carolina											1	50.0	57,000	57,000	72.2
North Dakota	1	.7	249,000	249,000	18.7						5	3.5	327,000	65,400	24.6
Ohio	11	.7	2,888,000	262,545	10.7	68	4.5	9,167,000	134,809	34.0	85	5.1	6,389,000	75,164	23.7
Oklahoma						4	2.4	449,000	112,250	16.0	14	8.3	924,000	66,000	33.0
Pennsylvania	105	2.4	31,781,000	302,676	28.1	216	4.9	29,988,000	138,833	26.5	292	6.6	20,289,000	69,483	17.9
South Dakota															
Tennessee	1	.4	215,000	215,000	4.4	11	4.5	1,441,000	131,000	29.5	14	5.7	1,016,000	72,571	20.8
Texas						1	2.5	121,000	121,000	10.9	2	5.1	123,000	61,500	11.1
Utah	9	20.9	2,909,000	323,222	58.3	10	23.3	1,653,000	165,300	33.1	4	9.3	280,000	70,000	5.6
Virginia	19	7.9	5,996,000	315,579	57.1	13	5.4	1,868,000	143,692	17.8	12	5.0	766,000	63,833	7.3
Washington	3	6.3	724,000	241,333	28.1	9	18.8	1,199,000	133,222	46.5	4	8.3	269,000	47,250	10.4
West Virginia	71	3.6	20,970,000	295,352	26.1	170	8.5	23,809,000	140,053	29.6	242	12.2	17,031,000	70,376	21.2
Wyoming	6	7.7	1,487,000	247,833	24.9	22	28.2	2,970,000	135,000	49.7	17	21.8	1,286,000	75,647	21.6
	416	2.9	131,876,000	317,010	31.2	848	6.0	117,195,000	138,202	27.8	1,084	7.7	77,287,000	71,298	18.3

Number and production of commercial bituminous-coal mines (including wagon mines) in the United States in 1922, by classes—Contd.

State.	Class 4 (10,000 to 50,000 tons).					Class 5 (less than 10,000 tons).					Total.		
	Mines.		Production.			Mines.		Production.			Mines.	Production (net tons).	
	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.	Number.	Percentage.	Total (net tons).	Average per mine (net tons).	Percentage.		Total.	Average per mine.
Alabama	96	25.7	2,458,000	25,604	13.4	174	46.5	402,000	2,310	2.2	374	18,325,000	48,997
Alaska, California, Idaho, and Oregon	3	18.7	86,000	28,667	81.1	13	81.3	20,000	1,538	18.9	16	106,000	6,625
Arkansas	28	21.5	613,000	21,893	55.2	99	76.2	307,000	3,101	27.7	130	1,110,000	8,538
Colorado	59	22.6	1,519,000	25,746	15.1	143	55.0	409,000	2,860	4.1	260	10,020,000	38,538
Georgia											1	61,000	61,000
Illinois	124	16.2	3,206,000	25,855	5.5	378	49.4	738,000	1,952	1.3	765	58,467,000	76,427
Indiana	89	17.9	2,404,000	27,011	12.6	298	59.7	511,000	1,715	2.7	499	19,133,000	38,343
Iowa	56	27.1	1,371,000	24,482	31.6	122	58.9	257,000	2,107	5.9	207	4,335,000	20,942
Kansas	42	15.5	1,037,000	24,690	35.1	210	77.5	523,000	2,500	17.8	271	2,955,000	10,904
Kentucky	354	16.1	9,090,000	25,678	21.6	1,597	72.7	1,705,000	1,068	4.0	2,199	42,134,000	19,161
Maryland	24	20.3	522,000	21,750	42.6	87	73.8	219,000	2,517	17.9	118	1,223,000	10,365
Michigan	3	23.0	115,000	38,333	12.4	2	15.4	10,000	5,000	1.1	13	929,000	71,462
Missouri	63	28.4	1,354,000	21,492	46.3	143	64.3	355,000	2,483	12.2	222	2,925,000	13,176
Montana	11	16.7	249,000	22,636	9.8	42	63.6	84,000	2,000	3.2	66	2,572,000	38,970
New Mexico	4	7.0	89,000	22,250	2.8	28	49.2	70,000	2,500	2.2	57	3,147,000	55,211
North Carolina	1	50.0	22,000	22,000	27.8						2	79,000	39,500
North Dakota	25	17.5	482,000	19,280	36.3	112	78.3	270,000	2,411	20.4	143	1,328,000	92,867
Ohio	275	18.3	6,255,000	22,745	23.3	1,065	70.8	2,255,000	2,117	8.3	1,504	26,954,000	17,922
Oklahoma	57	33.7	1,214,000	21,298	43.3	94	55.6	215,000	2,287	7.7	169	2,802,000	16,580
Pennsylvania	1,023	23.0	24,280,000	23,734	21.5	2,809	63.1	6,810,000	2,424	6.0	4,445	113,148,000	25,455
South Dakota						16	100.0	8,000	500	100.0	16	8,000	500
Tennessee	70	28.7	1,786,000	25,514	36.7	148	60.7	419,000	2,831	8.6	244	4,877,000	19,988
Texas	30	77.0	829,000	27,633	75.0	6	15.4	33,000	5,500	3.0	39	1,106,000	28,359
Utah	4	9.3	121,000	30,250	2.4	16	37.2	29,000	1,813	.6	43	4,992,000	116,093
Virginia	63	26.3	1,580,000	25,079	15.1	133	55.4	281,000	2,113	2.7	240	10,491,000	43,713
Washington	12	25.0	308,000	25,667	11.9	20	41.6	81,000	4,050	3.1	48	2,581,000	53,771
West Virginia	618	31.2	16,042,000	25,942	19.8	880	44.5	2,636,000	2,995	3.3	1,981	80,488,000	40,630
Wyoming	5	6.4	171,000	34,200	2.9	28	35.9	58,000	2,071	.9	78	5,972,000	76,564
	3,139	22.1	77,203,000	24,595	18.3	8,663	61.3	18,707,000	2,159	4.4	14,150	422,268,000	29,842

WAGON MINES IN 1922.

No attempt was made to ascertain the output of country coal banks without access to a railroad, because it had been found from previous efforts that though the number of banks runs into the thousands, they contribute less than a million tons to the yearly supply of coal. (See p. 536.) Statistics were assembled, however, from the railroads, of the number of wagon mines shipping by rail. The number of wagon mines of this class identified in 1922 was 4,851, as against 4,405 in 1920.[7] The production of the wagon mines in 1922 reached 3,459,442 tons, as compared with 4,513,800 tons in 1920.

The estimated value of the coal produced by the wagon mines in 1922 was $15,699,650, as compared with $25,739,000 in 1920. The average value per ton declined from $5.70 in 1920 to $4.54 in 1922. Alabama reported the smallest average value per ton for wagon-mine coal in 1922 ($2.98), and Maryland and Pennsylvania the highest ($4.90). Pennsylvania led in total production and also in the number of mines. The number, however, (1,570) was less than the total reported for 1920. Kentucky, on the other hand, showed a large increase in the number of small operations and reported 1,299 wagon mines in 1922.

Number and production of wagon mines shipping bituminous coal by rail in 1922.

State.	Number.	Production (net tons).	Estimated value.	State.	Number.	Production (net tons).	Estimated value.
Alabama	94	96,300	$287,000	Ohio	559	308,544	$1,336,000
Arkansas	28	24,000	104,000	Oklahoma	41	19,446	85,000
Colorado	25	25,135	98,000	Pennsylvania	1,570	1,446,190	7,086,000
Illinois	154	90,105	383,000	South Dakota	1	50	150
Indiana	203	182,465	774,000	Tennessee	70	44,371	177,000
Iowa	48	38,900	156,000	Utah	3	650	2,500
Kansas	138	178,924	778,000	Virginia	72	52,873	227,000
Kentucky	1,299	468,053	2,100,000	Washington	1	3,750	17,000
Maryland	33	29,956	147,000	West Virginia	365	254,589	1,222,000
Missouri	60	75,418	302,000	Wyoming	16	13,586	51,000
Montana	13	14,831	58,000				
New Mexico	17	31,442	129,000		4,851	3,459,442	15,699,650
North Dakota	41	59,864	180,000				

NUMBER AND OUTPUT OF PRODUCERS AS DISTINCT FROM MINES.

RANGE OF OUTPUT.

The foregoing statistics represent the number of mines or openings. It remains to show the number of producing companies, which is less than the number of openings, because some of the largest companies operate dozens or scores of mines. In the following table, which was prepared in collaboration with the President's Conference on Unemployment, each corporation, partnership, or individual reporting production to the Geological Survey in 1920 has been classified by the size of his total output. The year 1920 was selected for this analysis because the market conditions in that year were such as to call into active operation all the producing enterprises. There were 12,122 producing enterprises reported as contributing to the supply of bituminous coal in 1920. Of these, 1,440 were country banks (a number that doubtless would have been larger

[7] See U. S. Geol. Survey Mineral Resources, 1921, pt. 2, p. 324, 1923.

had it been possible to ascertain them all), and 4,405 were wagon mines shipping by rail. The commercial producers proper numbered 6,277. Among them were 795 companies, individuals, or partnerships that produced less than 2,000 tons each. The aggregate contribution of these 795 shippers was 838,000 tons, only 0.15 per cent of the total output. Yet these producers were sufficiently well established, in spite of their small tonnage, to be classed by the Geological Survey as "commercial" or "local commercial," as distinct from the mushroom-like wagon mines. At the other end of the scale were four companies that produced 5,000,000 tons or more each. These four companies operated 213 mines and contributed 40,505,000 tons to the supply of the country. Between these two groups were ranged the rest of the commercial shippers.

Bituminous-coal producers in 1920, classified by size of output.

	Number of producers in each class.	Number of mines operated.	Total output (net tons).
Country banks reporting	1,440	1,440	420,911
Wagon mines shipping by rail, other than local commercial mines	4,405	4,405	4,513,800
Commercial and local commercial mines producing			
Less than 2,000 tons	795	798	838,483
2,000 to 4,999 tons	806	814	2,604,260
5,000 to 9,999 tons	748	781	5,337,029
10,000 to 49,999 tons	2,121	2,381	53,348,269
50,000 to 99,999 tons	727	974	51,242,458
100,000 to 199,999 tons	543	888	75,508,562
200,000 to 299,999 tons	202	424	49,019,958
300,000 to 399,999 tons	94	215	32,965,932
400,000 to 499,999 tons	52	152	23,390,433
500,000 to 599,999 tons	33	98	17,914,499
600,000 to 699,999 tons	28	70	18,007,916
700,000 to 799,999 tons	20	122	14,969,468
800,000 to 899,999 tons	12	89	10,112,361
900,000 to 999,999 tons	16	140	14,149,119
1,000,000 to 1,249,999 tons	17	128	18,691,389
1,250,000 to 1,499,999 tons	9	119	12,471,314
1,500,000 to 1,749,999 tons	11	82	17,935,541
1,750,000 to 1,999,999 tons	10	97	18,747,933
2,000,000 to 2,499,999 tons	10	101	20,329,863
2,500,000 to 2,999,999 tons	7	110	21,697,649
3,000,000 to 4,999,999 tons	12	125	43,943,573
5,000,000 tons or more	4	213	40,505,963
	12,122	14,766	568,666,683

The relative numbers of large and small producers become clearer in the following table, which expresses the data of the table just given in the form of percentages of the totals, both absolute and cumulative. It is a familiar fact that the bituminous-coal industry is competitive and broken up into a large number of small units. More than two-thirds (67.60 per cent) of the total number of producers had an output in 1920 of less than 10,000 tons each and operated 55.78 per cent of the mines. In spite of their large numbers and of the burdens laid upon the railroads in supplying them with cars, the aggregate contribution made by these little shippers to the country's supply of coal is small. It amounted in 1920 to but 2.41 per cent of the entire output.

No less characteristic of the bituminous-coal industry is the large company operating several mines, employing up-to-date machinery and equipment, and maintaining a complete sales organization of its own. There were 189 producing corporations that reported an output of 500,000 tons or more each in 1920. These 189 companies, constituting but 1.54 per cent of the total number of producers, never-

theless contributed nearly half (47.39 per cent) of the country's supply of coal. Again, there are 80 companies that produce 1,000,000 tons or more each a year and that contribute more than a third (34.17 per cent) of the total output.

In the preparation of these tables each corporation reporting to the Geological Survey has been treated as a unit and no account has been taken of the interlocking ownership or interests of these companies. The tables therefore understate the degree of concentration of ownership in the bituminous-coal mining industry. To give a single illustration, the several producing companies affiliated with the United States Steel Corporation are shown not as one but as individual companies. Thus the Tennessee Coal, Iron & Railroad Co., producing in Alabama and Tennessee; the United States Coal & Coke Co., operating in Kentucky and West Virginia; the H. C. Frick Coke Co., largest of the producers in the Connellsville region; and the United States Fuel Co., mining in Indiana and southern Illinois, are counted in the tables as separate corporations. Were they thrown together to represent a single financial interest, the degree of concentration would appear greatly increased. Such financial affiliation or community of interest is of course common, not merely among the largest companies, but also within the smaller groups producing from 50,000 to 500,000 tons a year.

Bituminous-coal producers in 1920, classified by size of output, in percentages.

	Percentage of total					
	Absolute			Cumulative		
	Producers	Mines	Output	Producers	Mines	Output
Country banks reporting	11.88	9.75	0.07	11.88	9.75	0.07
Wagon mines shipping by rail, other than local commercial mines	36.34	29.83	.79	48.22	39.58	.86
Commercial and local commercial mines producing:						
Less than 2,000 tons	6.56	5.40	.15	54.78	44.98	1.01
2,000 to 4,999 tons	6.65	5.51	.46	61.43	50.49	1.47
5,000 to 9,999 tons	6.17	5.29	.94	67.60	55.78	2.41
10,000 to 49,999 tons	17.50	16.12	9.38	85.10	71.90	11.79
50,000 to 99,999 tons	6.00	6.60	9.01	91.10	78.50	20.80
100,000 to 199,999 tons	4.48	6.01	13.28	95.58	84.51	34.08
200,000 to 299,999 tons	1.67	2.87	8.62	97.25	87.38	42.70
300,000 to 399,999 tons	.78	1.46	5.80	98.03	88.84	48.50
400,000 to 499,999 tons	.43	1.03	4.11	98.46	89.87	52.61
500,000 to 599,999 tons	.27	.66	3.15	98.73	90.53	55.76
600,000 to 699,999 tons	.23	.48	3.17	98.96	91.01	58.93
700,000 tp 799,999 tons	.16	.83	2.63	99.12	91.84	61.56
800,000 to 899,999 tons	.10	.60	1.78	99.22	92.44	63.34
900,000 to 999,999 tons	.13	.95	2.49	99.35	93.39	65.83
1,000,000 to 1,249,999 tons	.14	.87	3.29	99.49	94.26	69.12
1,250,000 to 1,499,999 tons	.07	.81	2.19	99.56	95.07	71.31
1,500,000 to 1,749,999 tons	.09	.56	3.15	99.65	95.63	74.46
1,750,000 to 1,999,999 tons	.08	.66	3.30	99.73	96.29	77.76
2,000,000 to 2,499,999 tons	.08	.68	3.58	99.81	96.97	81.34
2,500,000 to 2,999,999 tons	.06	.74	3.82	99.87	97.71	85.16
3,000,000 to 4,999,999 tons	.10	.85	7.72	99.97	98.56	92.88
5,000,000 tons or more	.03	1.44	7.12	100.00	100.00	100.00

NUMBER OF PRODUCERS, BY STATES.

The information presented for the United States in the preceding tables is still more instructive when itemized by States, as in the four tables that follow. In these tables, however, the country banks and wagon mines have been omitted, and the figures represent only the commercial operations. The presentation is further simplified by grouping the companies into five classes, ranging from those

companies that mine less than 10,000 tons each annually to those that mine more than 500,000 tons. In this class of largest output there are 189 companies. The entries for a given State include all the corporations operating in that State whose total output is above the size limit for the class, regardless of whether that output is made entirely within that particular State. A corporation like the Central Coal & Coke Co. would therefore be listed in five different States. From this fact there arises a certain double counting, and the sum of each of the columns as they stand is therefore in excess of the actual total of corporations within the corresponding size group.

It is instructive to compare the relative size of companies under different conditions of mining. In Illinois, where the general necessity of sinking shafts puts a premium on large-scale operations, there are 44 corporations in the class producing 500,000 tons or more. In West Virginia, a State whose aggregate tonnage is slightly greater than that of Illinois, there were in 1920 only 28 such corporations. In the next group, companies producing from 100,000 to 499,000 tons, West Virginia had 181 enterprises, as against 108 in Illinois, and in the smaller groups the lead of West Virginia was still greater. The chief cause is no doubt the greater ease of opening a mine where the coal crops out on the right of way of an existing railroad and can be reached by a drift or slope.

As might be expected, Pennsylvania led all other States in the number of companies in each size group. Of the 6,277 commercial producers of record in 1920, 1,833 operated in Pennsylvania.

Number of bituminous-coal companies in 1920, classified by size of output.

[Includes only commercial and local commercial companies.]

State	500,000 tons or more.	100,000 to 499,000 tons.	50,000 to 99,000 tons.	10,000 to 49,000 tons.	Under 10,000 tons.	All companies.
Alabama	8	20	18	64	32	142
Alaska				2	8	10
Arkansas	1	1	4	32	35	73
California					2	2
Colorado	3	19	16	38	51	127
Georgia			1			1
Idaho					1	1
Illinois	44	108	42	78	118	390
Indiana	11	71	39	43	90	254
Iowa	1	22	20	37	75	155
Kansas	2	15	6	32	63	118
Kentucky	10	77	69	268	232	656
Maryland	1	12	15	18	20	66
Michigan	2		3	3		8
Missouri	1	12	16	44	102	175
Montana	2	8	3	9	47	69
New Mexico	2	3	2	6	10	23
North Carolina				1		1
North Dakota		1	2	15	62	80
Ohio	21	85	70	247	379	782
Oklahoma	1	12	15	38	27	93
Oregon				1	2	3
Pennsylvania	54	224	194	656	705	1,833
South Dakota					17	17
Tennessee		19	19	49	35	122
Texas		5	3	21	3	32
Utah	2	11	1	2	15	31
Virginia	4	10	15	35	38	102
Washington	2	5	4	15	6	32
West Virginia	28	181	159	380	172	920
Wyoming	3	14	1	5	12	35
	203	915	737	2,139	2,359	6,353
Total excluding duplications [a]	189	891	727	2,121	2,349	6,277

[a] Duplications arise through the same company operating in more than one State.

Number of mines operated by bituminous-coal companies in 1920.

[Companies classified by size of output.]

State.	500,000 tons or more.	100,000 to 499,999 tons.	50,000 to 99,999 tons.	10,000 to 49,999 tons.	Under 10,000 tons.	All companies.
Alabama	80	52	25	68	32	257
Alaska				2	8	10
Arkansas	7	7	8	36	38	96
California					2	2
Colorado	51	24	16	40	52	183
Georgia			1			1
Idaho					1	1
Illinois	144	128	43	89	118	522
Indiana	53	91	41	43	90	318
Iowa	2	42	28	39	75	186
Kansas	14	44	6	34	64	162
Kentucky	71	132	91	283	234	811
Maryland	13	24	23	21	22	103
Michigan	8		3	3		14
Missouri	4	29	22	48	102	205
Montana	3	14	4	9	49	79
New Mexico	16	9	2	6	10	43
North Carolina				1		1
North Dakota		1	2	15	61	79
Ohio	160	115	90	276	389	1,030
Oklahoma	5	35	28	46	28	142
Oregon				1	2	3
Pennsylvania	473	459	285	752	725	2,694
South Dakota					17	17
Tennessee		41	27	63	35	166
Texas		11	5	25	3	44
Utah	9	12	1	2	15	39
Virginia	27	18	17	41	38	141
Washington	11	8	5	17	6	47
West Virginia	256	386	212	427	175	1,456
Wyoming	29	22	1	5	12	69
	1,436	1,704	986	2,392	2,403	8,921

Output of bituminous-coal companies in 1920, in thousands of net tons.

[Companies classified by size of output.]

State.	500,000 tons or more.	100,000 to 499,999 tons.	50,000 to 99,999 tons.	10,000 to 49,999 tons.	Under 10,000 tons.	All companies.
Alabama	8,728	4,318	1,218	1,712	165	16,141
Alaska				46	15	61
Arkansas	681	162	313	760	134	2,050
California						
Colorado	6,354	3,547	1,107	1,099	167	12,274
Georgia			50			50
Idaho					3	3
Illinois	58,058	25,070	3,059	2,049	396	88,632
Indiana	10,299	14,675	2,899	928	289	29,090
Iowa	677	4,574	1,415	895	214	7,775
Kansas	1,535	2,778	365	900	260	5,838
Kentucky	9,119	14,022	4,650	6,843	895	35,529
Maryland	824	1,634	1,052	427	93	4,030
Michigan	1,172		237	79		1,488
Missouri	530	2,133	1,089	1,137	378	5,267
Montana	1,678	2,167	238	218	104	4,405
New Mexico	2,551	789	162	152	30	3,684
North Carolina				12		12
North Dakota		245	123	327	213	908
Ohio	20,266	12,543	5,021	6,010	1,438	45,278
Oklahoma	542	2,044	1,066	1,077	101	4,830
Oregon				18	2	20
Pennsylvania	92,534	43,512	13,244	16,030	2,765	168,085
South Dakota					13	13
Tennessee		3,944	1,365	1,098	179	6,586
Texas		792	194	622	6	1,614
Utah	3,187	2,649	83	61	23	6,003
Virginia	7,457	1,727	1,053	828	179	11,244
Washington	2,104	932	294	402	21	3,753
West Virginia	30,311	36,835	11,570	10,027	708	89,451
Wyoming	5,573	3,803	93	126	28	9,623
	264,180	184,895	51,960	53,883	8,819	563,737

Percentage of total production in each State produced by bituminous coal companies classified by size of output in 1920.

[Calculated from tonnages in preceding table.]

State.	500,000 tons or more.	100,000 to 499,999 tons.	50,000 to 99,999 tons.	10,000 to 49,999 tons.	Under 10,000 tons.	All companies.
Alabama	54.1	26.8	7.5	10.6	1.0	100.0
Alaska				75.4	24.6	100.0
Arkansas	33.2	7.9	15.3	37.1	6.5	100.0
California						
Colorado	51.8	28.9	9.0	9.0	1.3	100.0
Georgia			100.0			100.0
Idaho					100.0	100.0
Illinois	65.4	28.3	3.5	2.3	0.5	100.0
Indiana	35.4	50.4	10.0	3.2	1.0	100.0
Iowa	8.7	58.8	18.2	11.5	2.8	100.0
Kansas	26.3	47.6	6.3	15.4	4.4	100.0
Kentucky	25.7	39.5	13.1	19.2	2.5	100.0
Maryland	20.4	40.5	26.1	10.6	2.4	100.0
Michigan	78.8		15.9	5.3		100.0
Missouri	10.1	40.3	20.6	21.8	7.2	100.0
Montana	38.1	49.2	5.4	4.9	2.4	100.0
New Mexico	69.3	21.4	4.4	4.1	.8	100.0
North Carolina				100.0		100.0
North Dakota		27.0	13.5	36.0	23.5	100.0
Ohio	44.7	27.7	11.1	13.3	3.2	100.0
Oklahoma	11.2	42.3	22.1	22.3	2.1	100.0
Oregon				90.0	10.0	100.0
Pennsylvania	55.1	25.9	7.9	9.5	1.6	100.0
South Dakota					100.0	100.0
Tennessee		59.9	20.7	16.7	2.7	100.0
Texas		49.1	12.0	38.5	.4	100.0
Utah	53.1	44.1	1.4	1.0	.4	100.0
Virginia	66.3	15.4	9.4	7.4	1.5	100.0
Washington	56.1	24.8	7.8	10.7	.6	100.0
West Virginia	33.9	41.2	12.9	11.2	.8	100.0
Wyoming	57.9	39.5	1.0	1.3	.3	100.0
	46.8	32.8	9.2	9.6	1.6	100.0

TREND OF SIZE OF PRODUCING CORPORATION.

In view of the known consolidations that have taken place recently, it is somewhat surprising to learn that the relative importance of large and small producing corporations has changed but little in the last 15 years. The early records do not permit comparison of the number of wagon mines, but if the commercial companies only are considered, it will be found that there has been surprisingly little shift from one size class to another, either in the number of the corporations or in the number of mines they operate and the tonnage they produce. Such a comparison is made for the years 1905 and 1920 in the following table. It indicates that during the 15-year period the number of large and small commercial companies had been increasing at proportionately the same rate. In 1905, for example, companies mining 5,000,000 tons or more a year contributed 7.6 per cent of the commercial output. In 1920 they contributed 7.2 per cent. In 1905, as in 1920, slightly more than half the output came from companies mining less than 500,000 tons a year. In this connection, however, it should again be noted that the tables count each producing corporation as a unit, regardless of possible affiliations with other corporations. Were it possible to group affiliated enterprises together, it might of course appear that consolidation had progressed farther since 1905 than the record of individual corporations would indicate. In the second table the data for 1905 are shown in greater detail than in the summary.

Trend of size of producing bituminous-coal corporations, 1905 and 1920.

[Data include commercial and local commercial producers only.]

Size of output.	Percentage of total operators.		Percentage of total mines.		Per cent of total quantity produced.	
	1905	1920	1905	1920	1905	1920
Absolute percentage:						
Less than 10,000 tons	42.8	37.4	29.9	26.8	1.6	1.6
10,000 to 49,999 tons	27.6	33.8	21.4	26.7	7.8	9.4
50,000 to 99,999 tons	11.6	11.6	11.1	10.9	8.9	9.1
100,000 to 499,999 tons	15.2	14.2	20.3	18.8	33.4	32.1
500,000 to 999,999 tons	1.4	1.7	4.5	5.8	10.8	13.3
1,000,000 to 4,999,999 tons	1.3	1.2	10.4	8.6	29.9	27.3
5,000,000 tons or more	.1	.1	2.4	2.4	7.6	7.2
	100.0	100.0	100.0	100.0	100.0	100.0
Cumulative percentage:						
Less than 10,000 tons	42.8	37.4	29.9	26.8	1.6	1.6
Less than 50,000 tons	70.4	71.2	51.3	53.5	9.4	11.0
Less than 100,000 tons	82.0	82.8	62.4	64.4	18.3	20.1
Less than 500,000 tons	97.2	97.0	82.7	83.2	51.7	52.2
Less than 1,000,000 tons	98.6	98.7	87.2	89.0	62.5	65.5
Less than 5,000,000 tons	99.9	99.9	97.6	97.6	92.4	92.8
All operators	100.0	100.0	100.0	100.0	100.0	100.0

Commercial bituminous-coal producers, classified by size of output in 1905.

[This table is based upon the reports of all commercial coal producers (including also so-called local commercial mines) received by the United States Geological Survey for the year 1905. No figures are available covering that year for the number of country banks, nor the number of wagon mines, except such as are included in the commercial mines. The banks and wagon mines omitted produced at that time 0.2 per cent of the tonnage.]

Size of output (net tons.)	Number of producers.	Number of mines.	Total output (net tons.)	Percentage of total.					
				Absolute.			Cumulative.		
				Producers.	Mines.	Output.	Producers.	Mines.	Output.
Less than 2,000	552	552	627,796	15.84	10.90	0.20	15.84	10.90	0.20
2,000 to 4,999	561	568	1,775,884	16.10	11.23	.56	31.94	22.13	.76
5,000 to 9,999	379	392	2,608,719	10.88	7.75	.83	42.82	29.88	1.59
10,000 to 49,999	961	1,086	24,567,056	27.58	21.46	7.81	70.40	51.34	9.40
50,000 to 99,999	403	561	27,988,230	11.57	11.09	8.89	81.97	62.43	18.29
100,000 to 199,999	331	530	45,955,598	9.50	10.47	14.60	91.47	72.90	32.89
200,000 to 299,999	119	274	28,703,630	3.42	5.41	9.12	94.89	78.31	42.01
300,000 to 399,999	48	129	16,424,886	1.38	2.54	5.22	96.27	80.85	47.23
400,000 to 499,999	32	95	14,234,978	.92	1.88	4.52	97.19	82.73	51.75
500,000 to 599,999	15	59	8,171,637	.43	1.17	2.60	97.62	83.90	54.35
600,000 to 699,999	15	82	9,667,050	.43	1.62	3.07	98.05	85.52	57.42
700,000 to 799,999	7	31	5,339,205	.20	.61	1.70	98.25	86.13	59.12
800,000 to 899,999	6	21	5,138,155	.17	.42	1.63	98.42	86.55	60.75
900,000 to 999,999	6	33	5,704,806	.17	.65	1.81	98.59	87.20	62.56
1,000,000 to 1,249,999	15	88	17,267,145	.43	1.74	5.49	99.02	88.94	68.05
1,250,000 to 1,499,999	3	17	4,157,800	.09	.34	1.32	99.11	89.28	69.37
1,500,000 to 1,749,999	9	102	14,453,074	.26	2.02	4.59	99.37	91.30	73.96
1,750,000 to 1,999,999	3	54	5,565,621	.09	1.07	1.77	99.46	92.37	75.73
2,000,000 to 2,499,999	7	89	15,347,321	.20	1.76	4.88	99.66	94.13	80.61
2,500,000 to 2,999,999	2	16	5,254,907	.06	.32	1.67	99.72	94.45	82.28
3,000,000 to 4,999,999	8	160	31,938,544	.22	3.16	10.15	99.94	97.61	92.43
5,000,000 or more	2	121	23,824,268	.06	2.39	7.57	100.00	100.00	100.00
	3,484	5,060	314,716,310						

To find any marked change in the average size of the corporations producing bituminous coal we must go back further than 1905. If we go back to 1895 we find that the relative number and production of the largest companies diminish in importance. Whereas com-

panies producing more than 500,000 tons contributed 48.3 per cent of the total output in 1905, in 1895 they contributed but 29.2 per cent. In the earlier year 29.1 per cent of the total output came from companies producing less than 100,000 tons, as against 18.3 per cent in 1905 and 20.1 per cent in 1920. This comparison omits country banks and wagon mines, but were figures for them available the result would be practically the same. The data for 1895 given in the following tables were compiled by the Geological Survey in cooperation with C. E. Lesher, of the United States Coal Commission, and two of the three tables are reproduced from the commission's report on engineering and management.

Trend of size of producing bituminous-coal corporations, 1895 to 1920.

[Data include only commercial and local commercial producers of bituminous coal. Each operating corporation is treated as one producer regardless of possible affiliations with other corporations.]

Size of output.	Percentage of total number of producers.			Percentage of total production.		
	1895.	1905.	1920.	1895.	1905.	1920.
Less than 10,000 tons	47.3	42.8	37.4	2.1	1.6	1.6
10,000 to 49,999 tons	26.6	27.6	33.8	11.6	7.8	9.4
50,000 to 99,999 tons	12.8	11.6	11.6	15.4	8.9	9.1
100,000 to 499,999 tons	11.9	15.2	14.2	41.7	33.4	32.1
500,000 tons or more	1.4	2.8	3.0	29.2	48.3	47.8
	100.0	100.0	100.0	100.0	100.0	100.0

Number of bituminous-coal producers classified by size of output in 1895, by States.

State.	500,000 tons or more.	100,000 to 499,999 tons.	50,000 to 99,999 tons.	10,000 to 49,999 tons.	Under 10,000 tons.	Total.
Alabama	2	5	4	20	12	43
Arkansas	1			1	4	6
California				3	2	5
Colorado	1	4	2	12	34	53
Georgia		2				2
Illinois	4	38	44	101	555	742
Indiana		11	19	23	19	72
Indian Territory		4		1	3	8
Iowa		8	13	47	68	136
Kansas	1	7	4	10	38	60
Kentucky		5	4	10	6	25
Maryland	4	4	1	2	1	12
Michigan				4	3	7
Missouri		2	7	18	52	79
Montana	1	1	2	2	10	16
New Mexico		3		2	7	12
North Carolina				1	1	2
North Dakota				1	4	5
Ohio	2	28	39	93	101	263
Oregon			1	1	2	4
Pennsylvania	13	102	84	143	64	406
Tennessee		6	11	9	10	36
Texas		1		8	4	13
Utah		1		3	7	11
Virginia	1		2	10	6	19
Washington		5	1	4	10	20
West Virginia	1	29	44	60	24	158
Wyoming	1	2	3	1	8	15
	32	268	285	590	1,055	2,230

Production of bituminous-coal producers classified by size of output in 1895, by States.

State.	500,000 tons or more.	100,000 to 499,999 tons.	50,000 to 99,999 tons.	10,000 to 49,999 tons.	Under 10,000 tons.	Total.
Alabama	4,389,486	953,474	266,360	434,411	33,725	6,077,456
Arkansas	698,196	----------	----------	17,000	19,200	734,396
California	----------	----------	----------	66,603	8,850	75,453
Colorado	1,471,667	1,082,696	114,487	332,068	65,909	3,066,827
Georgia	----------	260,998	----------	----------	----------	260,998
Illinois	4,283,583	6,985,355	2,984,092	2,408,503	925,506	17,587,039
Indiana	----------	1,929,523	1,368,941	556,985	86,489	3,941,938
Indian Territory	----------	1,098,800	----------	30,500	5,303	1,134,603
Iowa	----------	1,714,736	1,009,112	937,406	275,245	3,936,499
Kansas	954,827	1,560,449	291,209	245,291	121,694	3,173,470
Kentucky	----------	1,078,848	226,435	233,277	29,220	1,567,780
Maryland	2,636,291	1,059,580	67,299	20,401	5,282	3,788,853
Michigan	----------	----------	----------	99,554	10,240	109,794
Missouri	----------	582,431	501,996	458,327	194,727	1,737,481
Montana	501,627	197,200	107,700	51,798	11,250	869,575
New Mexico	----------	630,692	----------	69,526	7,461	707,679
North Carolina	----------	----------	----------	19,400	1,500	20,900
North Dakota	----------	----------	----------	20,160	15,437	35,597
Ohio	1,164,613	6,141,477	2,750,832	1,958,863	420,746	12,436,531
Oregon	----------	----------	58,025	11,200	4,460	73,685
Pennsylvania	18,798,118	20,230,975	5,811,705	4,288,863	250,234	49,379,895
Tennessee	----------	809,199	759,525	218,388	54,225	1,841,337
Texas	----------	283,932	----------	182,433	11,340	477,705
Utah	----------	352,165	----------	58,403	15,175	425,743
Virginia	890,365	----------	132,274	295,113	11,515	1,329,267
Washington	----------	975,074	85,688	106,410	20,878	1,188,050
West Virginia	574,351	5,523,183	3,244,606	1,825,317	71,712	11,239,169
Wyoming	1,382,393	583,480	218,450	36,870	13,588	2,234,781
	37,745,517	54,034,267	19,998,736	14,983,070	2,690,911	[a] 129,452,501

[a] From records now available. United States Geological Survey reported 135,118,193 net tons in Mineral Resources for 1895.

ANTHRACITE PRODUCERS, CLASSIFIED BY SIZE OF OUTPUT.

In sharp contrast to the wide dissemination of ownership in the bituminous-coal mining industry, the production of anthracite is concentrated in the hands of the few companies. The Geological Survey has records of 174 producing units that were active in 1920. Of these, 58 were engaged solely in dredging rivers of the anthracite region for fine coal washed down from the mines. Of producers operating mines or culm-bank washeries, the Survey has records of only 116.

The distribution of the 174 companies, individuals, and partnerships by size classes is given in the following table, together with the number of operations of the producers in each class. The anthracite industry is not lacking in small units producing less than 2,000 tons a year each, but whereas there are 6,640 enterprises of that size in the bituminous fields (p. 536), there are but 17 in the anthracite region. The characteristic producing unit of the anthracite industry is the large company operating several breakers and washeries and making an output of over a million tons. Such companies produced 75 per cent of the total output in 1920. In fact, practically half of the output was contributed by four companies of the so-called railroad-affiliated group that operated 86 breakers and 27 washeries and produced 39,028,973 tons of coal. The following tables present the data for the Pennsylvania anthracite region in a form similar to those covering the bituminous-coal industry given above. Again it should be noted that each corporation is treated as a unit without regard to interlocking ownership or interest between companies.

Thus Coxe Bros. and the Lehigh Valley Coal Co. are here counted as separate producers. Were it possible to combine accurately the several producing interests the degree of concentration of ownership would appear much greater.

Anthracite producers in 1920, classified by size of output.

Size of output (gross tons).	Number of producers.	Number of operations of these producers.			
		Breakers.	Washeries.	Dredges.	Total.
Less than 2,000 tons	17	4		13	17
2,000 to 4,999 tons	12	4		8	12
5,000 to 9,999 tons	18	4		14	18
10,000 to 49,999 tons	38	15	2	22	39
50,000 to 99,999 tons	21	15	5	1	21
100,000 to 199,999 tons	27	26	4		30
200,000 to 299,999 tons	14	15	1		16
300,000 to 399,999 tons	4	4	1		5
400,000 to 499,999 tons	5	7	5		12
500,000 to 599,999 tons	2	2			2
600,000 to 699,999 tons	1	1			1
700,000 to 799,999 tons					
800,000 to 899,999 tons	2	4	1		5
900,000 to 999,999 tons					
1,000,000 to 1,249,999 tons	3	13			13
1,250,000 to 1,499,999 tons	1	9	1		10
1,500,000 to 1,749,999 tons	1	5			5
1,750,000 to 1,999,999 tons					
2,000,000 to 2,499,999 tons					
2,500,000 to 2,999,999 tons					
3,000,000 to 4,999,999 tons	4	38	15	2	55
5,000,000 tons or more	4	86	27		113
	174	252	62	60	374

Size of output (gross tons).	Total output.			
	Breakers.	Washeries.	Dredges.	Total.
Less than 2,000 tons	4,192		14,422	18,614
2,000 to 4,999 tons	15,688		27,727	43,415
5,000 to 9,999 tons	33,006		104,943	137,949
10,000 to 49,999 tons	358,820	31,548	420,732	811,100
50,000 to 99,999 tons	989,946	365,481	75,000	1,430,427
100,000 to 199,999 tons	3,650,850	318,936		3,969,786
200,000 to 299,999 tons	3,404,033	16,411		3,420,444
300,000 to 399,999 tons	1,276,145	73,666		1,349,811
400,000 to 499,999 tons	1,538,324	595,431		2,133,755
500,000 to 599,999 tons	1,120,253			1,120,253
600,000 to 699,999 tons	668,822			668,822
700,000 to 799,999 tons				
800,000 to 899,999 tons	1,740,044	3,555		1,743,599
900,000 to 999,999 tons				
1,000,000 to 1,249,999 tons	3,539,732			3,539,732
1,250,000 to 1,499,999 tons	1,437,040	43,614		1,480,654
1,500,000 to 1,749,999 tons	1,707,452			1,707,452
1,750,000 to 1,999,999 tons				
2,000,000 to 2,499,999 tons				
2,500,000 to 2,999,999 tons				
3,000,000 to 4,999,999 tons	15,892,066	1,483,290	18,295	17,393,651
5,000,000 tons or more	36,291,640	2,737,333		39,028,973
	73,668,053	5,669,265	661,119	79,998,437

Anthracite producers in 1920, classified by size of output in percentages.

Size of output (gross tons).	Percentage of total.					
	Absolute.			Cumulative.		
	Producers.	Operations.	Output.	Producers.	Operations.	Output.
Less than 2,000 tons	9.77	4.55	0.02	9.77	4.55	0.02
2,000 to 4,999 tons	6.90	3.21	.05	16.67	7.76	.07
5,000 to 9,999 tons	10.35	4.81	.17	27.02	12.57	.24
10,000 to 49,999 tons	21.85	10.43	1.01	48.87	23.00	1.25
50,000 to 99,999 tons	12.07	5.61	1.79	60.94	28.61	3.04
100,000 to 199,999 tons	15.52	8.02	4.96	76.46	36.63	8.00
200,000 to 299,999 tons	8.05	4.28	4.28	84.51	40.91	12.28
300,000 to 399,999 tons	2.30	1.34	1.69	86.81	42.25	13.97
400,000 to 499,999 tons	2.87	3.21	2.67	89.68	45.46	16.64
500,000 to 599,999 tons	1.15	.53	1.40	90.83	45.99	18.04
600,000 to 699,999 tons	.57	.27	.84	91.40	46.26	18.88
700,000 to 799,999 tons				91.40	46.26	18.88
800,000 to 899,999 tons	1.15	1.34	2.18	92.55	47.60	21.06
900,000 to 999,999 tons				92.55	47.60	21.06
1,000,000 to 1,249,999 tons	1.73	3.48	4.43	94.28	51.08	25.49
1,250,000 to 1,499,999 tons	.57	2.67	1.85	94.85	53.75	27.34
1,500,000 to 1,749,999 tons	.57	1.34	2.14	95.42	55.09	29.48
1,750,000 to 1,999,999 tons				95.42	55.09	29.48
2,000,000 to 2,499,999 tons				95.42	55.09	29.48
2,500,000 to 2,999,999 tons				95.42	55.09	29.48
3,000,000 to 4,999,999 tons	2.30	14.71	21.74	97.72	69.80	51.22
5,000,000 tons or more	2.28	30.20	48.78	100.00	100.00	100.00
	100.00	100.00	100.00			

CONTRAST BETWEEN SIZE OF ANTHRACITE AND BITUMINOUS-COAL COMPANIES.

The contrast between the prevailing unit of production in the anthracite and bituminous coal industries is brought out even more clearly in the following summary table. Companies producing 5,000,000 tons or more contribute 48.8 per cent of the anthracite output, as against only 7.1 per cent of the output of bituminous coal.

Anthracite and bituminous-coal producers, classified by size of output.

Size of output.[a]	Number of producers in each size class.		Percentage of total output in each size class.	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.
Less than 10,000 tons	47	8,194	0.2	2.4
10,000 to 49,999 tons	38	2,121	1.0	9.4
50,000 to 99,999 tons	21	727	1.8	9.0
100,000 to 499,999 tons	50	891	13.6	31.8
500,000 to 999,999 tons	5	109	4.4	13.2
1,000,000 to 4,999,999 tons	9	76	30.2	27.1
5,000,000 tons or more	4	4	48.8	7.1
	174	12,122	100.0	100.0

[a] The unit used in this tonnage classification is the net ton of 2,000 pounds for bituminous-coal producers, and the gross ton of 2,240 pounds for anthracite producers. This difference is offset by the large percentage of the anthracite output that is required for mine fuel.

VALUE OF COAL PRODUCED.

DEFINITION OF VALUES REPORTED.

The value given in this report is the amount received at the mines f. o. b. cars, and the average value per ton is the average amount received, obtained by dividing the total value by the number of tons sold or produced. Coal used at the mine, coal coked by the producing company, and coal used in some other industry by that company—

in all forming a considerable part of the total output—is not sold, and the value placed upon it is either an estimate or the amount at which it is carried on the company's books. Either value is presumably the amount the coal would have brought if it had been sold or the amount other fuel for the purpose stated would have cost if it had been purchased. In other words, the values given represent returns to the operators for coal sold plus the estimated value of that not sold. The value thus fixed is more or less arbitrary and does not necessarily represent the current prices for coal sold commercially. Many mines are owned by consumers who take all or a great part of their output at nominal prices. The output of such "captive mines" is not known accurately, but it is probably between 20 and 25 per cent of the entire production. Even where the coal is actually sold large quantities may be moved on "cost plus" contracts that provide for prices far below the average spot prices in the field or the average prices received for coal delivered under ordinary contracts. The figures in the following tables therefore do not necessarily show prices or even an average of the prices of coal at the mines. Taken over a period of years, however, they do furnish an index to the rise and fall in the value of coal.

CHANGE IN METHOD OF REPORTING VALUE.

A change in the method of compilation of the statistics of value made in 1922 should be mentioned here. For some years operators had been requested to give separate statements of value for coal loaded at mines for shipment, coal sold to local trade, mine fuel, and coal made into beehive coke at the mines. The object of making these separate reports was to separate, where possible, noncommercial business from the sales to the ordinary independent buyers. It was not possible, however, to distinguish in the value of "coal loaded at mines for shipment" between the output of a commercial mine and the output of the "captive mines" owned or controlled by consumers, because the consumer affiliations of the several shippers were not known to the Geological Survey.

It was found that the values placed by operators upon mine fuel and also upon coal sold locally were generally somewhat less than the average amounts received for coal shipped. The quantities to which these lower values for coal not shipped applied were, however, so much smaller than the quantities shipped that they affected only slightly the average value of all coal produced. Thus in 1921 the average value of all bituminous coal shipped was $2.90 a ton, and the average of all coal produced including mine fuel, coal sold locally and coal coked, was $2.89, only 1 cent less. The difference between the two figures is so small that for practical purposes the average value per ton of coal produced may be accepted as a measure of the value of coal at the mine. The Geological Survey has therefore discontinued the collection of separate returns of value for coal shipped, coal sold locally, mine fuel, and coal coked and beginning with 1922 has asked only for the total value of the entire output.

Value of coal produced in the United States in 1921.

[Exclusive of product of wagon mines.]

State.	Loaded at mines for shipment.		Sold to local trade and used by employees.		Used at mine for steam and heat.		Made into coke at mines.		Total.	Average per ton.
	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.		
Alabama	$36,642,000	$3.10	$830,000	$2.65	$813,000	$2.78	$428,000	$3.33	$38,713,000	$3.08
Alaska	464,000	6.44	20,000	6.66	12,000	6.62			496,000	6.46
Arkansas	5,100,000	4.34	138,000	7.08	122,000	3.62			5,360,000	4.37
California, Idaho, and Oregon	98,000	5.16	54,000	4.06	29,000	4.44			181,000	4.66
Colorado	30,164,000	3.59	1,253,000	3.13	765,000	3.01	195,000	3.22	32,377,000	3.55
Georgia	83,000	4.43	1,000	2.68	7,000	3.54	80,000	6.30	171,000	2.14
Illinois	174,843,000	2.72	10,823,000	3.21	5,320,000	2.59			190,986,000	2.74
Indiana	49,203,000	2.57	1,675,000	2.74	1,391,000	2.35			52,269,000	2.57
Iowa	14,663,000	3.77	2,269,200	4.35	324,600	2.74			17,256,800	3.81
Kansas	12,540,000	3.86	399,000	3.58	394,300	3.76			13,333,300	3.85
Kentucky	81,266,000	2.70	2,070,000	2.58	1,303,600	2.47	453,000	2.80	85,092,600	2.69
Maryland	6,316,000	3.62	181,000	3.19	105,000	3.85			6,602,000	3.61
Michigan	5,225,000	4.93	60,000	5.28	270,000	3.77			5,555,000	4.87
Missouri	12,538,700	3.90	1,049,100	4.33	327,700	3.28			13,915,500	3.92
Montana	8,345,200	3.35	392,300	3.40	184,100	1.46			8,921,600	3.26
New Mexico	9,203,000	3.95	116,000	3.34	177,000	2.84	89,000	2.92	9,585,000	3.91
North Carolina	120,000	6.00			15,000	4.36			135,000	5.76
North Dakota	1,940,000	2.77	332,000	2.45	57,500	2.02			2,329,500	2.69
Ohio	78,864,000	2.65	4,303,600	2.76	1,518,500	2.56	400	2.14	84,686,500	2.65
Oklahoma	14,919,300	4.65	128,700	5.03	498,000	3.87			15,546,000	4.62
Pennsylvania (bituminous)	286,617,000	2.81	11,888,000	2.75	6,908,300	2.71	17,125,000	2.40	322,538,300	2.78
South Dakota	1,500	3.34	19,600	2.77	100	2.94			21,200	2.81
Tennessee	14,164,000	3.38	279,000	3.16	384,000	3.10	105,000	1.94	14,932,000	3.35
Texas	2,498,700	2.64	13,200	4.91	51,700	2.29			2,563,600	2.64
Utah	[a]13,243,000	[a]3.61	230,000	3.08	189,000	2.58	(a)	(a)	13,662,000	3.35
Virginia	21,102,500	3.09	391,200	2.56	253,000	2.56	1,201,000	2.84	22,947,700	3.06
Washington	9,277,000	4.07	241,000	4.04	236,000	2.66	33,000	5.25	9,787,000	4.03
West Virginia	195,003,400	2.84	8,699,600	2.91	2,183,300	2.70	775,200	2.28	206,661,500	2.84
Wyoming	22,410,400	3.26	325,000	3.14	623,100	2.81			23,358,500	3.24
Total bituminous	1,106,854,700	2.90	48,181,500	2.99	24,462,800	2.68	20,484,600	2.38	1,199,983,600	2.89
Pennsylvania anthracite	430,990,000	5.53	11,934,000	4.24	9,381,000	.96			452,305,000	5.00
Grand total	1,537,844,700	3.34	60,115,500	3.17	33,843,800	3.47	20,484,600	2.38	1,652,288,600	3.26

[a] Value of coal made into coke at the mines included in that of coal loaded at mines for shipment.

Value of coal produced in the United States in 1922.

State.	Net tons.	Value.	
		Total.	Average per ton.
Alabama	18,324,740	$42,856,000	$2.34
Alaska	79,275	431,000	5.43
Arkansas	1,110,046	4,592,000	4.14
California, Idaho, and Oregon	26,893	104,000	3.87
Colorado	10,019,597	31,701,000	3.16
Georgia	60,636	246,000	4.06
Illinois	58,467,736	168,925,000	2.89
Indiana	19,132,889	54,524,000	2.85
Iowa	4,335,161	16,119,000	3.72
Kansas	2,955,170	10,816,000	3.66
Kentucky	42,134,175	127,037,000	3.02
Maryland	1,222,707	4,122,000	3.37
Michigan	929,390	4,693,000	5.05
Missouri	2,924,750	11,153,000	3.81
Montana	2,572,221	8,208,500	3.19
New Mexico	3,147,173	10,977,000	3.49
North Carolina	78,570	388,000	4.94
North Dakota	1,327,564	3,513,000	2.65
Ohio	26,953,791	87,056,000	3.23
Oklahoma	2,802,511	11,527,000	4.11
Pennsylvania (bituminous)	113,148,308	351,777,000	3.11
South Dakota	7,752	22,000	2.84
Tennessee	4,876,774	14,096,000	2.89
Texas	1,106,007	2,563,000	2.32
Utah	4,992,008	15,687,500	3.14
Virginia	10,491,174	27,083,000	2.58
Washington	2,581,165	10,279,000	3.98
West Virginia	80,488,192	236,162,000	2.93
Wyoming	5,971,724	18,162,000	3.04
Total bituminous, including wagon mines	422,268,099	1,274,820,000	3.02
Pennsylvania anthracite	54,683,022	273,700,000	5.01
Grand total	476,951,121	1,548,520,000	3.25

ESTIMATES OF VALUE INCLUDED IN THE STATISTICS.

If an operator who is known to have produced coal during the year will make no report of the value of his product to the Geological Survey an estimate of the value is included in the total in order to make it complete. In earlier years the number of estimates thus made necessary was so small that their inclusion could in no way impair the substantial accuracy of the total, but in 1920 and again in 1922 a considerable number of operators were unwilling to disclose the amount they had received for their coal. If, after correspondence with each operator that did not report value, the Geological Survey was unable to ascertain the amount from him, it was estimated by multiplying the number of tons of output reported by him by the average spot price per ton in the district as given by Coal Age. The same method was followed in estimating the value of coal produced at new mines from which the Survey heard indirectly through railroads or State mine inspectors, for the information obtained from these sources showed the output but not the value. The percentage of the total value of the product in each State in 1922 represented in this report by estimates is shown in the following table:

Percentage of total value of bituminous coal produced in 1922 by commercial operators that is represented by estimates.

Alabama	7.5	Ohio	9.2
Arkansas	19.4	Oklahoma	4.9
Colorado	8.5	Pennsylvania	5.7
Illinois	2.9	South Dakota	22.7
Indiana	5.3	Tennessee	5.5
Iowa	16.9	Texas	10.2
Kansas	10.5	Utah	8.2
Kentucky	19.0	Virginia	2.0
Maryland	9.3	Washington	29.8
Missouri	8.4	West Virginia	8.1
Montana	4.9	Wyoming	3.3
New Mexico	1.2		
North Carolina	20.4	United States	7.8
North Dakota	11.7		

Of the $1,274,820,000 given as the total value of bituminous coal at the mines in 1922, $99,171,000, or 7.8 per cent, represents estimates of the value of the output of commercial mines. The total also includes an item of $15,699,650 for the value placed by the Survey on the product of about 4,900 wagon mines, which represented approximately 0.8 per cent of the total output. In all, therefore, estimates had to be made for the value of about 8.6 per cent of the output in 1922. In the average for the whole country the proportion estimated is not large enough to introduce an appreciable error, but in the figures for some of the States the error may be serious.

FLUCTUATIONS IN VALUE AND PRICE.

The average value of bituminous coal was 13 cents per net ton greater in 1922 than in 1921. Compared with 1920, the average was 73 cents less. The comparison is significant. Although the demand in 1922 did not approach that of the spring and summer of 1920, either in volume or in intensity, the panicky conditions were heightened in 1922 by the strike in both the anthracite region and the organized bituminous-coal fields. That the average for 1922 fell so far short of that for 1920 may be attributed chiefly to the facts set forth below.

Industrial consumers and retail yards entered the boom period of 1920 with one of the lowest reserve stocks on record. The strike late in the winter of 1919 found many consumers unprepared, and little opportunity to build up reserves was afforded between the end of that strike and April 1, 1920, when the total stock in the hands of industrial consumers and retail dealers was between 20,000,000. and 24,000,000 tons. At the beginning of the 1922 strike, on the other hand, stocks in the hands of the carload buyers probably exceeded 63,000,000 tons. Moreover, the existence of a coal strike encouraged cautious purchasing, in marked contrast to the mad scramble for coal at any price in 1920.

The 1920 boom burst upon the industry almost without warning. The danger of a coal strike in 1922, on the other hand, was before the public from the first day of the calendar year, and between that time and April 1 the buyers managed to increase their storage stocks at least 15,000,000 tons, without starting a runaway market. Many forehanded consumers placed orders with nonunion producing fields

early in the year, when competition for business was still keen. As a result, when the strike got under way perhaps 70 per cent of the nonunion output was under contract at prices substantially less than those obtainable in the spot market.

In 1920 several attempts were made by the Attorney General of the United States to set up extra legal price-fixing committees in different parts of the country and to proceed against shippers charging "unreasonable" prices through court action. The movement was a practical failure. In May, 1922, the Secretary of Commerce called a conference of operators at Washington and procured pledges from most of them to observe as maximum prices on spot sales figures fixed by him. These prices were based upon the Fuel Administration maxima, with such modifications as it was felt were warranted by changed conditions. The program of cooperative price control was carried on by the Federal Fuel Distributor when he took over the work initiated by the Secretary of Commerce. Although undeviating adherence to the maximum prices so fixed was not attained, their promulgation did exercise a decided effect upon spot quotations.

In comparing individual State averages the relative output and the commercial development must be taken into account. Changes in Alaska, California, Georgia and North Carolina, for example, are much less significant than those in the great coal-producing States, such as Pennsylvania, West Virginia, Illinois, Ohio, Kentucky, Indiana, and Alabama. The average value in Alabama declined 74 cents a ton in 1922. Pennsylvania, one of the storm centers of the strike, showed an increase of 33 cents in the average value of bituminous coal over that for 1921, but this average was 99 cents less than the figure for 1920. Compared with the preceding year, the average on West Virginia coals advanced only 9 cents; Illinois, 15 cents; Indiana, 28 cents; Kentucky, 33 cents; Ohio, 58 cents.

The average value of anthracite increased only 1 cent a ton in 1922. The reasons for this apparent lack of increase in a year when the domestic sizes frequently sold at a premium are discussed in greater detail on pages 641–643.

Average value per net ton of coal at the mines in the United States, 1880–1922.

Year.	Anthracite.[a]	Bituminous.	Year.	Anthracite.[a]	Bituminous.	Year.	Anthracite.[a]	Bituminous.
1880	$1.47	$1.25	1895	$1.41	$0.86	1910	$1.90	$1.12
1881	2.01	1.12	1896	1.50	.83	1911	1.94	1.11
1882	2.01	1.12	1897	1.51	.81	1912	2.11	1.15
1883	2.01	1.07	1898	1.41	.80	1913	2.13	1.18
1884	1.79	.94	1899	1.46	.87	1914	2.07	1.17
1885	2.00	1.13	1900	1.49	1.04	1915	2.07	1.13
1886	1.95	1.05	1901	1.67	1.05	1916	2.30	1.32
1887	2.01	1.11	1902	1.84	1.12	1917	2.85	2.26
1888	1.91	1.00	1903	2.04	1.24	1918	3.40	2.58
1889	1.44	.99	1904	1.90	1.10	1919	4.14	2.49
1890	1.43	.99	1905	1.83	1.06	1920	4.85	3.75
1891	1.46	.99	1906	1.85	1.11	1921	5.00	2.89
1892	1.57	.99	1907	1.91	1.14	1922	5.01	3.02
1893	1.59	.96	1908	1.90	1.12			
1894	1.51	.91	1909	1.84	1.07			

[a] Averages for anthracite represent amounts per net ton and include all coal produced.

Average value per net ton of coal at the mines, 1908–1922.

State.	1908	1909	1910	1911	1912	1913	1914	1915
Alabama	$1.26	$1.19	$1.26	$1.27	$1.29	$1.31	$1.34	$1.28
Alaska	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Arkansas	1.68	1.48	1.56	1.61	1.71	1.76	1.72	1.79
California	[b] 3.19	[b] 2.21	[b] 2.74	[b] 2.00	[b] 2.33	[b] 3.54	[c] 2.85	[c] 2.54
Colorado	1.41	1.33	1.42	1.45	1.49	1.52	1.66	1.58
Georgia	1.38	1.41	1.46	[d] 1.49	[d] 1.49	1.41	[e] 1.44	1.72
Idaho	4.02	4.27	3.92	[f] 2.68	[f] 3.14	2.43	(c)	(c)
Illinois	1.05	1.05	1.14	1.11	1.17	1.14	1.12	1.10
Indiana	1.06	1.02	1.13	1.08	1.14	1.11	1.10	1.10
Iowa	1.63	1.65	1.75	1.73	1.80	1.79	1.79	1.78
Kansas	1.49	1.44	1.61	1.53	1.62	1.67	1.64	1.66
Kentucky	1.01	.94	.99	.99	1.02	1.05	1.02	1.01
Maryland	1.17	1.11	1.12	1.11	1.18	1.24	1.27	1.28
Michigan	1.81	1.79	1.91	1.78	1.99	1.99	1.99	2.05
Missouri	1.64	1.65	1.79	1.72	1.76	1.73	1.73	1.73
Montana	1.96	1.97	1.82	1.79	1.82	1.74	1.75	1.62
New Mexico	1.37	1.29	1.39	1.44	1.42	1.46	1.61	1.44
North Carolina				(d)	(d)			
North Dakota	1.63	1.56	1.49	1.43	1.53	1.52	1.52	1.45
Ohio	1.06	.99	1.05	1.03	1.07	1.10	1.13	1.08
Oklahoma	2.03	2.00	2.22	2.05	2.14	2.05	2.06	2.01
Oregon	2.74	2.69	3.48	2.32	2.60	2.53	2.78	2.84
Pennsylvania (bituminous)	1.01	.94	1.02	1.01	1.05	1.11	1.07	1.06
South Dakota						1.96	1.73	1.55
Tennessee	1.15	1.09	1.11	1.12	1.14	1.14	1.14	1.13
Texas	1.80	1.72	1.67	1.66	1.67	1.77	1.69	1.65
Utah	1.69	1.66	1.68	1.69	1.67	1.65	1.59	1.58
Virginia	.91	.89	.90	.91	.96	1.01	1.01	.98
Washington	2.21	2.54	2.50	2.29	2.39	2.38	2.20	2.17
West Virginia	.95	.86	.92	.90	.94	1.01	.99	.97
Wyoming	1.62	1.55	1.55	1.56	1.58	1.56	1.55	1.46
Total bituminous	1.12	1.07	1.12	1.11	1.15	1.18	1.17	1.13
Pennsylvania anthracite [g]	1.90	1.84	1.90	1.94	2.11	2.13	2.07	2.07

State.	1916	1917	1918	1919	1920	1921	1922	
							Average.	Increase or decrease.
Alabama	$1.37	$2.27	$2.85	$2.96	$3.65	$3.08	$2.34	−$0.74
Alaska	4.00	4.92	5.45	5.66	5.83	6.46	5.43	−1.03
Arkansas	1.92	2.56	3.67	3.70	4.56	4.37	4.14	−.23
California	[c] 2.12	[c] 2.30	[c] 2.70	[c] 3.38	[c] 4.36	[c] 4.66	[c] 3.87	−.79
Colorado	1.62	2.22	2.69	2.78	3.49	3.55	3.16	−.39
Georgia	1.79	2.53	3.59	3.71	5.00	2.14	4.06	+1.92
Idaho	(c)	(c)	(c)	(a)	(a)	(a)	(a)	(a)
Illinois	1.25	1.88	2.32	2.30	3.08	2.74	2.89	+.15
Indiana	1.27	1.99	2.29	2.22	3.16	2.57	2.85	+.28
Iowa	1.86	2.35	3.02	3.09	3.94	3.81	3.72	−.09
Kansas	1.78	2.31	2.91	3.05	3.87	3.85	3.66	−.19
Kentucky	1.19	2.17	2.55	2.46	4.11	2.69	3.02	+.33
Maryland	1.56	2.46	2.77	2.73	4.63	3.61	3.37	−.24
Michigan	2.25	3.22	3.83	3.88	4.93	4.87	5.05	+.18
Missouri	1.91	2.43	3.02	3.21	4.16	3.92	3.81	−.11
Montana	1.73	2.11	2.53	2.67	3.16	3.26	3.19	−.07
New Mexico	1.47	1.86	2.68	3.11	3.68	3.91	3.49	−.42
North Carolina			4.75	3.84	7.02	5.76	4.94	−.82
North Dakota	1.49	1.80	2.45	2.50	2.87	2.69	2.65	−.04
Ohio	1.33	2.48	2.58	2.22	3.82	2.65	3.23	+.58
Oklahoma	2.09	2.81	3.64	3.83	4.80	4.62	4.11	−.51
Oregon	2.68	3.38	2.81	3.40	4.49	(a)	(a)	(a)
Pennsylvania (bituminous)	1.30	2.44	2.59	2.42	3.77	2.78	3.11	+.33
South Dakota	2.03	2.90	2.80	3.17	3.60	2.81	2.84	+.03
Tennessee	1.23	2.19	2.83	2.77	4.02	3.35	2.89	−.46
Texas	1.56	1.77	2.63	2.69	3.75	2.64	2.32	−.32
Utah	1.62	2.07	2.71	2.76	3.22	3.35	3.14	−.21
Virginia	1.06	2.00	2.51	2.55	3.99	3.06	2.58	−.48
Washington	2.27	2.68	3.46	3.58	3.88	4.03	3.98	−.05
West Virginia	1.18	2.32	2.56	2.49	4.34	2.84	2.93	+.09
Wyoming	1.55	1.93	2.39	2.60	2.98	3.24	3.04	−.20
Total bituminous	1.32	2.26	2.58	2.49	3.75	2.89	3.02	+.13
Pennsylvania anthracite [g]	2.30	2.85	3.40	4.14	4.85	5.00	5.01	+.01

[a] Included with California.
[b] California includes Alaska.
[c] California includes Alaska, Idaho, and Nevada in 1914 and 1915; Idaho in 1916, 1917, 1918, 1919, 1920; and Idaho and Oregon in 1921 and 1922.
[d] Georgia includes North Carolina.
[e] Average for total output, including refuse from washery. The average, excluding refuse, was $1.71.
[f] Idaho includes Nevada.
[g] These values represent amounts per net ton and include all coal produced.

SPOT PRICES OF BITUMINOUS COAL.

The figures of average value collected by the Geological Survey are a composite of business covered by contract or trade connections of long standing at stable prices and business on the "open market," termed by the trade "spot sales." The percentage of coal moving under contract varies greatly from time to time and from district to district. There are no exact statistics of the relative proportions of spot and contract shipments, but it has been frequently stated that under ordinary conditions from 70 to 75 per cent of the total output moves under contract.

Concerning the prices of contract coal little information is available. The trade quotations deal rather with the current spot price f. o. b. mine. The spot price reflects the monetary condition of the market, as interpreted by the buyer seeking low prices, on the one hand, and by the seller attempting to place his coal at the maximum profit, on the other. Much significance therefore attaches to the course of spot prices as an index to the state of trade. The spot price should not be taken, however, as a measure of the average profit of the coal producer.

In the following table is given the average spot price of bituminous coal f. o. b. mine for each month of the 17 years, 1906 to 1922, as published by Coal Age. (See also fig. 22.) The average is based upon the quotations reported by the correspondents of that journal for 14 coals representing nearly 90 per cent of the output of bituminous coal in the United States, weighted first with respect to the proportions of slack, prepared, and run of mine normally shipped, and second with respect to the quantity of each of these classes normally produced. For 1919 to 1922 the figures are those published currently by the Coal Age. For 1913 to 1918 they are taken from "Prices of coal and coke, 1913–1918," by C. E. Lesher, published in 1919 by the Geological Survey and the War Industries Board, modified slightly, however, to permit comparison with the post-war quotations. For 1906 to 1912 they are taken from a study by F. G. Tryon and W. F. McKenney, of the Geological Survey, in cooperation with the President's Conference on Unemployment, compiled in as nearly the same way as possible. Quotations from the Black Diamond, the Coal Trade Journal, and other sources have been pieced together to average with the same weight used by Lesher for the later years. For 12 of the 14 coals in the Coal Age index it was possible to obtain quotations back to 1906. For two of the coals used by Lesher—those of eastern and western Kentucky—the writers could find no quotations. An attempt was made to procure records of spot prices received by large producing companies that were in business throughout this period, but it was found that few companies could make accurate separation of their spot and contract receipts for the period in question. The quotations become less and less satisfactory as they are traced back into the earlier trade journals, and no journal seems to have made it a regular practice to report prices until about 1905. Naturally the accuracy of the quotations for any particular market varied with the care and skill of the correspondent in that market, and not all the quotations appeared trustworthy.

The coals selected for the group of 12 were those whose prices appeared to be most accurately quoted, yet even here there are ap-

parently discrepancies revealed by comparison of the quotations for one coal with those for others. There are a considerable number of gaps in the record. Where necessary, interpolation was made in

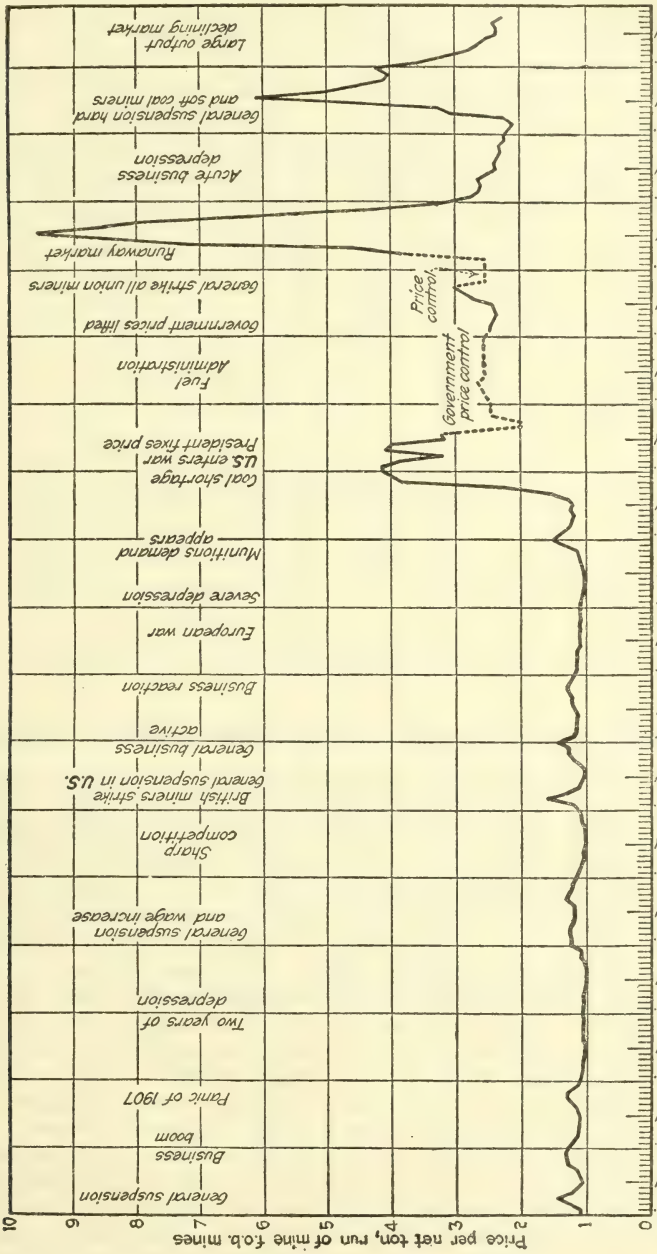


FIGURE 22.—Monthly average spot price of bituminous coal f. o. b. mines, 1906–1923.

order to complete the string of quotations. The figures are therefore subject to a certain margin of error, but they are believed to indicate the general course of prices during the period before the war. The

method of compilation is further explained in an article in Coal Age, volume 25, No. 3, pages 82–84, from which also Figure 22 is reproduced.

Monthly average spot price of bituminous coal f. o. b. mines 1906–1922, as published by Coal Age.

Month.	1906	1907	1908	1909	1910	1911	1912	1913	1914
January	$1.10	$1.28	$1.09	$1.06	$1.24	$1.16	$1.14	$1.46	$1.21
February	1.09	1.21	1.07	1.05	1.23	1.11	1.22	1.22	1.16
March	1.27	1.14	1.05	1.04	1.25	1.08	1.64	1.17	1.17
April	1.46	1.12	1.05	1.05	1.26	1.06	1.30	1.17	1.16
May	1.21	1.11	1.03	1.03	1.19	1.05	1.11	1.15	1.16
June	1.14	1.10	1.03	1.02	1.18	1.05	1.09	1.14	1.12
July	1.06	1.10	1.02	1.00	1.18	1.03	1.04	1.18	1.12
August	1.11	1.13	1.04	1.00	1.20	1.02	1.05	1.22	1.13
September	1.15	1.20	1.06	1.01	1.32	1.03	1.09	1.23	1.11
October	1.29	1.30	1.05	1.04	1.27	1.04	1.21	1.29	1.13
November	1.30	1.29	1.05	1.09	1.23	1.09	1.30	1.31	1.10
December	1.32	1.15	1.04	1.09	1.22	1.09	1.29	1.26	1.11
Average	1.21	1.18	1.05	1.04	1.23	1.07	1.21	1.23	1.14

Month.	1915	1916	1917	1918	1919	1920	1921	1922
January	$1.13	$1.53	$4.15	$2.48	$2.57	$2.57	$3.26	$2.25
February	1.12	1.40	4.18	2.53	2.49	2.58	2.77	2.20
March	1.09	1.27	3.89	2.58	2.47	2.58	2.63	2.12
April	1.08	1.24	3.21	2.64	2.43	3.85	2.62	2.24
May	1.07	1.21	4.14	2.67	2.38	4.59	2.68	3.11
June	1.07	1.26	4.00	2.57	2.40	7.18	2.52	3.31
July	1.05	1.22	3.17	2.58	2.47	8.24	2.40	4.67
August	1.07	1.30	3.24	2.58	2.76	9.51	2.42	6.13
September	1.10	1.57	2.02	2.58	2.91	8.52	2.37	5.38
October	1.12	2.26	2.02	2.58	3.09	7.78	2.33	4.48
November	1.17	3.87	2.48	2.58	2.57	5.87	2.35	4.11
December	1.33	4.01	2.48	2.58	2.58	4.38	2.26	4.05
Average	1.12	1.85	3.25	2.58	2.59	5.64	2.55	3.67

DIFFERENCE BETWEEN SPOT PRICE AND AVERAGE VALUE.

The spot price fluctuates more sharply than the average value on all coal produced. When the market is dull the spot price may fall below the contract level and therefore below the average receipts from all sales. In times of active demand it rises far above the contract level. A comparison of the spot price, as measured by the Coal Age average for the 14 representative coals, and the average receipts from sales of all coal produced, as reported by the Geological Survey, is made in the following table. In 6 out of the 17 years shown the spot price has been below the average receipts. In one year, 1918, the two figures were exactly the same, largely because the maximum prices set by the Fuel Administration applied to both spot and contract business, with the exception of bona fide contracts entered into prior to the establishment of Government prices. In 10 out of the 17 years the spot price was the higher of the two.

The spot price is not equal to the average receipts over a period of years, but is distinctly higher. Thus the average of the spot prices for the 17 years was $1.98 a ton, whereas the average amount received from sales during the same period was $1.74. This relation is explained by the fact that the spot price does not fall as far below the average value during periods of dull market as it rises above the average value during periods of intense demand. Thus in the year

of depression 1921, when the average spot price fell to the lowest level of record below the average value, the difference between the two figures was only 34 cents, yet in the preceding year, when spot prices reached their maximum, their average exceeded the average value by $1.89. The explanation of this fact is not far to seek. Prices can not for long remain below the cost of production, less perhaps depletion and depreciation, but there is theoretically no upper limit to which they can not rise. During the short age and runaway market of 1920, prices of $17 a ton f.o.b. mines were frequently quoted, and sales were no doubt made at still higher figures. To judge from the experience of Europe, even these prices, so extreme in the American market, do not measure the highest point to which consumers will go rather than do without coal.

Average spot price and average amount received per ton for bituminous coal, 1906–1922.

Year.	Coal Age's average spot price.	Average amount received.	Difference.	Year.	Coal Age's average spot price.	Average amount received.	Difference.
1906	$1.21	$1.11	+$0.10	1916	$1.85	$1.32	+$0.53
1907	1.18	1.14	+.04	1917	3.25	2.26	+.99
1908	1.05	1.12	−.07	1918	2.58	2.58	
1909	1.04	1.07	−.03	1919	2.59	2.49	+.10
1910	1.23	1.12	+.11	1920	5.64	3.75	+1.89
1911	1.07	1.11	−.04	1921	2.55	2.89	−.34
1912	1.21	1.15	+.06	1922	3.64	3.02	+.62
1913	1.23	1.18	+.05				
1914	1.14	1.17	−.03	Average 17 years	1.98	1.74	+.24
1915	1.12	1.13	−.01				

PRICES IN RELATION TO COSTS AND MARGINS.

Not only is the spot price to be avoided as an index to the profits of coal producers and dealers, but even the average sales realization may give a mistaken idea as to profits unless it is considered in connection with the cost of production. The fluctuations in relative profits during recent years are brought to view by the accompanying diagrams (figs. 23–26), reproduced from a study by David L. Wing and F. G. Tryon, entitled "The bituminous-coal industry in prosperity and depression," prepared for the mining session of the American Statistical Association, December 28, 1923. No attempt is made in these figures to measure the general level of profits in either the mining or the distribution of coal. The purpose is solely to indicate the relative profits from year to year under the changing conditions of the coal market.

BITUMINOUS COAL AND LIGNITE LOADED FOR SHIPMENT BY RAILROADS AND WATERWAYS.

According to the reports made to the Geological Survey by the coal operators, the quantity of bituminous coal and lignite loaded for shipment by railroads in 1922 amounted to 374,390,041 tons. The quantity loaded for shipment by waterways was 9,287,366 tons, making a total loaded at the mines for shipment of 383,677,407 tons.

The shipments by rail, which are summarized by railroads in the accompanying tables, include all coal loaded on cars at the mines. A

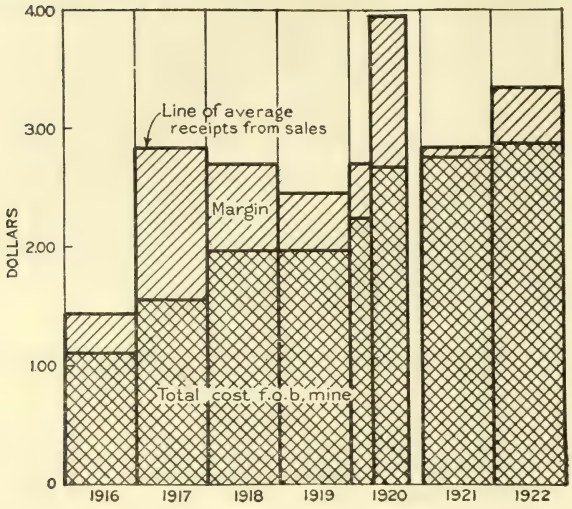


FIGURE 23.—Fluctuations in per ton cost, average receipts from sales, and margin of 127 bituminous-coal operators, 1916–1922. The operators shown are all in the northern Appalachian region. They are identical for each year except 1919 and 1920, for which reports of 123 operators have been interpolated, of whom 49 were common to the group of 127 operators.

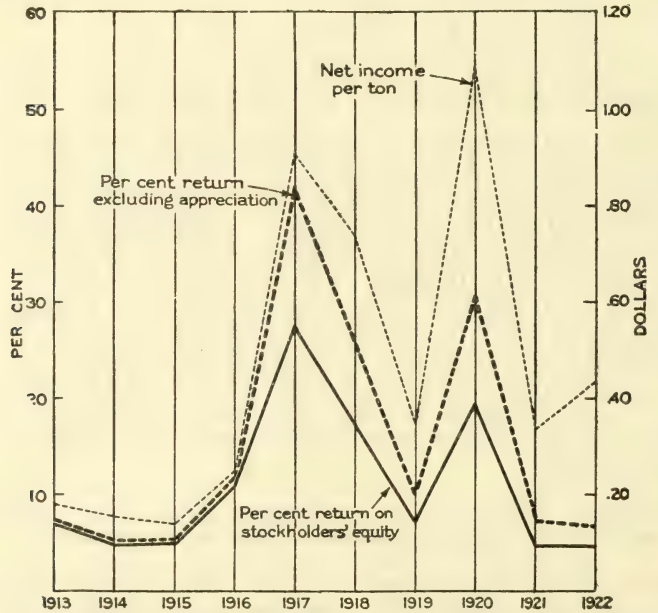


FIGURE 24.—Fluctuations in the profits of 52 large bituminous-coal operators, 1913–1922. The operators shown are all in the northern Appalachian region. Data from the United States Coal Commission's report on investment and profit in bituminous-coal mining, not yet published. The solid line represents percentage of return (before deducting Federal taxes) on stockholders' equity, including appreciation of values of coal-bearing land and other assets. The income on stockholders' equity after deducting these appreciations of value is shown by the heavier broken line.

small part of the coal shipped is carried only a short distance, perhaps only switched from the tipple to coke ovens near by or to some adjacent industrial plant, but the greater part is moved a considerable distance from the mines. As these statistics include coal used by

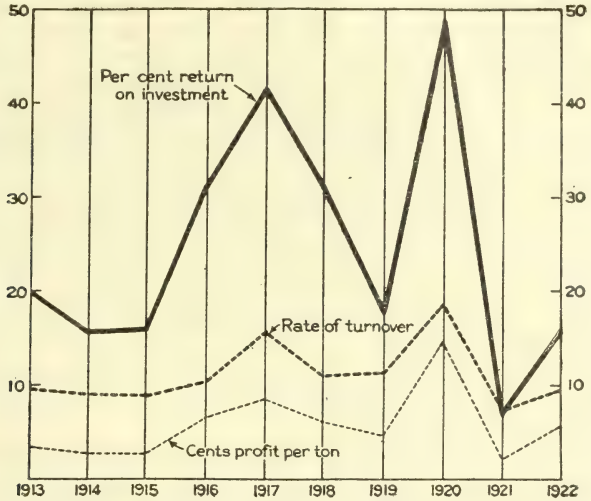


FIGURE 25.—Fluctuations in profits of 84 coal wholesalers, 1913–1922. Data from United States Coal Commission's report on wholesale and retail coal trade. Includes all companies reporting for each year of the 10-year period, some of whom handled anthracite. Profits are computed before payment of Federal taxes.

railroads that serve the coal mines, not all the shipments furnished revenue to the railroads, as coal for "company use" is nonrevenue freight. The statistics of coal traffic published by the railroad

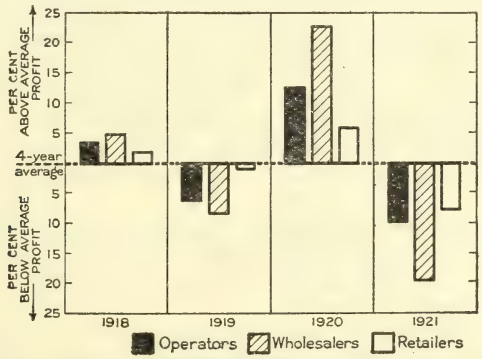


FIGURE 26.—Comparative range in yearly profits of bituminous-coal operators, wholesalers, and retailers, 1918–1921. In the bituminous-coal industry fluctuations in average profit between good and bad years are greatest for wholesalers, somewhat less for operators, and least for retailers. The bars in the diagram show the variation of the profit for each of the three groups above or below the group average for the four years 1918 to 1921, which is represented by the dotted base line. The data for operators are taken from the unaudited Federal tax returns of 1,234 bituminous-coal producers and represent per cent of net income to invested capital before deducting tax. The data for wholesalers include 84 identical companies (including a few companies handling chiefly anthracite) reporting to the United States Coal Commission and represent return on total investment. The data for retailers include 118 companies in the Central, Southern, and far Western States (regions where retailers handle chiefly bituminous coal) and represent return on total investment.

companies usually show only revenue freight and include coal received from connecting lines as well as that originating at mines on the lines reporting. For that reason the figures given in the following table may differ from those compiled by the railroads.

The railroads listed are those reported by the operators, and only a few reports of loadings on subsidiary roads have been consolidated under the name of the parent road. The shipments over the Coal & Coke Railroad have been included under the Baltimore & Ohio; and those over the Vandalia, the Pittsburgh, Cincinnati, Chicago & St. Louis, the Pennsylvania Co., the Ohio River & Western, and the Wheeling Terminal have been included under the Pennsylvania System. The Chicago, Terre Haute & Southeastern, over which operators of Indiana reported shipping 5,199,000 tons in 1920, was leased in 1921 by the Chicago, Milwaukee & St. Paul Railway, and the two are shown combined for 1922 under the name of the latter road.

For a number of other important groupings of railroads no attempt has been made to consolidate the several members into a total for the system. Thus the shipments on the line of the Oregon-Washington Railroad & Navigation Co. and the Oregon Short Line are shown separately from those over the Union Pacific; likewise the Toledo & Ohio Central, Zanesville & Western, Kanawha & Michigan, and Kanawha & West Virginia are shown separately. The statistics for the Cleveland, Cincinnati, Chicago & St. Louis Railroad are here shown exclusive of the Evansville, Indianapolis & Terre Haute and Peoria & Eastern Railroads.

The West Side Belt Railroad is not combined with the Pittsburgh & West Virginia Railroad. To the figures, for the Southern Railway should be added those for the Alabama Great Southern, Northern Alabama, Cincinnati, New Orleans & Texas Pacific, and Harriman & Northeastern to approximate the total for the Southern System. These illustrations will indicate the compilations of individual entries in the table necessary to give the total tonnage for a particular railroad interest. Coal loaded at mines of the Tennessee Coal, Iron & Railroad Co. is here shown under the name of that company rather than under the Birmingham Southern, the corporate designation of its railroad subsidiary.

In the corresponding table for 1919,[8] the entry given for the Atlanta, Birmingham & Atlantic Railroad included the coal originating on the Woodward Iron Co.'s railroad. The quantity loaded on the Woodward Iron Co.'s road during that year was 636,887 tons, leaving 104,973 tons as the quantity for the Atlanta, Birmingham & Atlantic Railroad proper. Beginning with 1920 these two roads have been shown separately.

The figures for the Chicago & Eastern Illinois Railroad include coal loaded in cars of the Elgin, Joilet & Eastern and moved by the latter road over the rails of the Chicago & Eastern Illinois under a trackage agreement.

The quantities shown in the following table as shipped by waterways do not all agree with the statistics on river traffic published by the United States Engineer Office. The shipments of coal on Monongahela River, according to the United States Engineer Office at Pittsburgh, amounted to 11,356,000 tons in 1922. The records of the Engineer Office should be accepted as a correct measure of the river traffic. The differences between these records and the reports of the operators to the Geological Survey are due to various causes, chiefly to the fact that shipments of coal loaded in cars at the mines and later transferred to boats would be classed by the Survey as "rail" and by the Engineer Office as "river."

[8] U. S. Geol. Survey Mineral Resources, 1921, pt. 2, p. 536, 1922.

Bituminous coal loaded for shipment in the United States in 1922, by railroads and waterways, in net tons.

Route.	State.	Quantity. By State.	Quantity. Total for route.
Railroads.			
Aerial Tram Electric	Pennsylvania	6,830	6,830
Akron, Canton & Youngstown	Ohio	62,134	62,134
Alabama Central	Alabama	70,064	70,064
Alabama Great Southern	do	12,831	12,831
Alaska	Alaska	73,382	73,382
Alton & Southern	Illinois	24,996	24,996
Altoona & Northern	Pennsylvania	1,083	1,083
Arkansas Central	Arkansas	1,200	1,200
Arkansas Western	do	2,411	2,411
Ashland Coal & Iron Co	Kentucky	166,692	166,692
Atchison, Topeka & Santa Fe	Colorado	571,621	3,878,747
	Illinois	245,578	
	Kansas	810,088	
	Missouri	460,978	
	New Mexico	1,729,314	
	Oklahoma	61,168	
Atlanta, Birmingham & Atlantic	Alabama	126,202	126,202
Ballard & Thompson	Utah	126,999	126,999
Baltimore & Ohio	Illinois	1,278,294	27,779,697
	Indiana	263,757	
	Kentucky	153,368	
	Maryland	33,607	
	Ohio	5,808,625	
	Pennsylvania	8,642,126	
	West Virginia	11,599,920	
Bessemer & Lake Erie	Pennsylvania	2,978,107	2,978,107
Bevier & Southern	Missouri	220,717	220,717
Big Sandy & Kentucky River	Kentucky	42,917	42,917
Black Mountain	do	20,735	20,735
Buffalo & Susquehanna	Pennsylvania	839,515	839,515
Buffalo Creek & Gauley	West Virginia	469,349	469,349
Buffalo, Rochester & Pittsburgh	Pennsylvania	5,522,943	5,522,943
Cambria & Indiana	do	1,954,395	1,954,395
Campbell's Creek	West Virginia	342,458	342,458
Carolina, Clinchfield & Ohio	Kentucky	122,856	2,739,167
	Virginia	2,616,311	
Caseyville	Illinois	29,832	29,832
Central Indiana	Indiana	18,800	18,800
Central of Georgia	Alabama	969,754	1,011,563
	Georgia	41,809	
Chattanooga & Montlake	Tennessee	53,056	53,056
Cheat Haven & Bruceton	West Virginia	280,787	280,787
Chesapeake & Ohio	Kentucky	3,648,819	25,394,332
	West Virginia	21,745,513	
Cheswick & Harmar	Pennsylvania	250,761	250,761
Chicago & Alton	Illinois	2,846,740	2,952,514
	Missouri	105,774	
Chicago & Eastern Illinois	Illinois	3,442,782	7,866,372
	Indiana	4,423,590	
Chicago & Illinois Midland	Illinois	1,914,680	1,914,680
Chicago & Northwestern	do	2,844,738	3,865,152
	Iowa	839,247	
	Wyoming	181,167	
Chicago, Burlington & Quincy	Colorado	542,049	11,578,574
	Illinois	9,123,402	
	Iowa	409,036	
	Missouri	255,118	
	Wyoming	1,248,969	
Chicago, Indianapolis & Louisville	Indiana	1,211,619	1,211,619
Chicago, Milwaukee & St. Paul	Illinois	436,399	6,603,577
	Indiana	4,585,800	
	Iowa	622,924	
	Missouri	33,591	
	Montana	762,122	
	North Dakota	130,292	
	South Dakota	450	
	Washington	31,999	
Chicago, Peoria & St. Louis	Illinois	401,808	401,808
Chicago, Rock Island & Gulf	Texas	58,771	58,771
Chicago, Rock Island & Pacific	Arkansas	55,999	1,859,512
	Colorado	38,583	
	Illinois	36,245	
	Iowa	937,736	
	Missouri	28,826	
	Oklahoma	762,123	

Bituminous coal loaded for shipment in the United States in 1922, by railroads and waterways, in net tons—Continued.

Route.	State.	Quantity. By State.	Quantity. Total for route.
Railroads—Continued.			
Cincinnati, Indianapolis & Western	Illinois	158,855	303,586
	Indiana	144,731	
Cincinnati, New Orleans & Texas Pacific	Tennessee	230,309	230,309
Cleveland, Cincinnati, Chicago & St. Louis	Illinois	4,697,793	6,153,889
	Indiana	1,456,096	
Clinton Block	Pennsylvania	7,514	7,514
Colfax Northern	Iowa	69,261	69,261
Colorado & Southeastern	Colorado	574,930	574,930
Colorado & Southern	do	2,465,926	2,465,926
Colorado & Wyoming	do	464,955	464,955
Colorado, Wyoming & Eastern	do	57,019	57,019
Cumberland	Kentucky	161,959	161,959
Cumberland & Manchester	do	135,154	135,154
Cumberland & Pennsylvania	Maryland	529,798	616,394
	Pennsylvania	86,596	
Dardanelle & Russellville	Arkansas	21,841	21,841
Denver & Intermountain	Colorado	165,342	165,342
Denver & Rio Grande Western	do	2,817,322	5,518,275
	New Mexico	27,244	
	Utah	2,673,709	
Denver & Salt Lake	Colorado	387,781	387,781
Des Moines & Central Iowa	Iowa	165,347	165,347
Detroit, Toledo & Ironton	Ohio	278,122	278,122
East Broad Top R. R. & Coal Co	Pennsylvania	261,817	261,817
Eastern Kentucky	Kentucky	58,477	58,477
Eastern Railway & Lumber Co	Washington	23,293	23,293
East St. Louis & Suburban	Illinois	532,344	532,344
Elgin, Joliet & Eastern	do	121,395	121,395
El Paso & Southwestern	New Mexico	855,308	855,308
Erie	Ohio	128,871	1,229,967
	Pennsylvania	1,101,096	
Evansville, Indianapolis & Terre Haute	Indiana	304,441	304,441
Evansville & Ohio Valley	do	108,292	108,292
Evansville, Suburban & Newburgh	do	143,243	143,243
Federal Valley	Ohio	96,701	96,701
Fort Dodge, Des Moines & Southern	Iowa	53,958	53,958
Fort Smith & Western	Oklahoma	101,559	101,559
Fort Smith, Subiaco & Rock Island	Arkansas	15,318	15,318
Galveston, Harrisburg & San Antonio	Texas	24,141	24,141
Grand Prairie Branch	Arkansas	15,545	15,545
Great Northern	Montana	674,167	1,120,379
	North Dakota	293,208	
	Washington	153,004	
Greenbrier & Eastern	West Virginia	372,877	372,877
Gulf Colorado & Santa Fe	Texas	1,270	1,270
Harriman & Northeastern	Tennessee	212,069	212,069
Hartland	West Virginia	66,380	66,380
Hocking Sunday Creek Traction	Ohio	18,058	18,058
Hocking Valley	do	2,473,755	2,473,755
Houston & Texas Central	Texas	121,120	121,120
Houston East & West Texas	do	89,095	89,095
Huntingdon & Broad Top Mountain	Pennsylvania	448,380	448,380
Illinois Central	Alabama	173,132	18,834,402
	Illinois	11,165,431	
	Indiana	365,353	
	Kentucky	7,130,486	
Illinois Central Electric	Illinois	6,000	6,000
Illinois Traction System	do	678,372	678,372
Indiana County Street Railway	Pennsylvania	8,976	8,976
Indian Creek & Northern	West Virginia	29,051	29,051
Indian Creek Valley	Pennsylvania	476,076	476,076
International & Great Northern	Texas	181,919	181,919
Interstate	Virginia	2,104,531	2,104,531
Iowa Southern Utilities Co	Iowa	90,024	90,024
Johnstown & Stony Creek	Pennsylvania	365,656	365,656
Joplin & Pittsburg	Kansas	20,171	20,171
Kanawha & Michigan	Ohio	774,418	2,307,354
	West Virginia	1,532,936	
Kanawha & West Virginia	do	155,404	155,404
Kanawha Central	do	74,327	74,327
Kanawha, Glen Jean & Eastern	do	433,366	433,366
Kansas City, Clinton & Springfield	Missouri	13,835	13,835
Kansas City Southern	Kansas	293,461	610,431
	Missouri	236,302	
	Oklahoma	80,668	

Bituminous coal loaded for shipment in the United States in 1922, by railroads and waterways, in net tons—Continued.

Route.	State.	Quantity.	
		By State.	Total for route.
Railroads—Continued.			
Kansas, Oklahoma & Gulf	Oklahoma	295,369	295,369
Kentucky & Tennessee	Kentucky	525,211	525,211
Kentucky Midland	do	136,449	136,449
Kentucky, Rock Castle & Cumberland	do	27,520	27,520
Lake Erie, Franklin & Clarion	Pennsylvania	609,590	609,590
Lenox	Kentucky	10,029	10,029
Ligonier Valley	Pennsylvania	810,371	810,371
Litchfield & Madison	Illinois	887,657	887,657
Long Fork	Kentucky	714,130	714,130
Louisville & Nashville	Alabama	3,972,002	26,742,381
	Illinois	687,722	
	Kentucky	21,121,282	
	Tennessee	746,892	
	Virginia	214,483	
Louisville, Henderson & St. Louis	Kentucky	306,311	306,311
Marion & Eastern	Illinois	290,305	290,305
Michigan Central	Michigan	447,352	447,352
Midland Valley	Arkansas	199,242	355,070
	Oklahoma	155,828	
Miller's Creek	Kentucky	124,821	124,821
Minneapolis & St. Louis	Illinois	719,185	934,323
	Iowa	215,138	
Minneapolis, St. Paul & Sault Ste. Marie	North Dakota	248,138	248,138
Missouri-Illinois	Illinois	208,540	208,540
Missouri, Kansas & Texas	Kansas	64,785	920,458
	Missouri	165,914	
	Oklahoma	445,899	
	Texas	243,860	
Missouri Pacific	Arkansas	570,189	3,913,018
	Illinois	2,086,547	
	Kansas	613,222	
	Missouri	638,610	
	Oklahoma	4,450	
Mobile & Ohio	Alabama	550,407	1,198,874
	Illinois	648,467	
Monongahela	Pennsylvania	3,071,340	5,225,169
	West Virginia	2,153,829	
Monongahela Valley Traction Co	do	1,155	1,155
Montana, Wyoming & Southern	Montana	449,057	449,057
Montour	Pennsylvania	2,474,405	2,474,405
Morehead & North Fork	Kentucky	6,176	6,176
Morgan & Fentress	Tennessee	15,326	15,326
Morgan Run	Ohio	3,276	3,276
Morgantown & Kingwood	West Virginia	283,607	283,607
Morgantown & Wheeling	do	1,851,765	1,851,765
Nashville, Chattanooga & St. Louis	Alabama	686	1,000,271
	Tennessee	999,585	
New Castle & Ohio River	Ohio	1,643	1,643
New Haven & Dunbar	Pennsylvania	62,548	62,548
New Mexico Central	New Mexico	6,368	6,368
New Mexico Midland	do	80,971	80,971
New York Central	Illinois	40,382	6,881,369
	Michigan	200	
	Ohio	1,799,099	
	Pennsylvania	5,021,846	
	West Virginia	19,842	
Norfolk & Western	Kentucky	3,511,473	29,904,221
	Ohio	31,426	
	Virginia	3,060,230	
	West Virginia	23,301,092	
Norfolk Southern	North Carolina	68,524	68,524
Northern Alabama	Alabama	702,428	702,428
Northern Maryland & Tidewater	Maryland	18,138	18,138
Northern Pacific	Montana	509,745	2,461,940
	North Dakota	406,501	
	Washington	1,545,694	
Norton & Northern	Virginia	93,411	93,411
Ohio & Kentucky	Kentucky	59,559	59,559
Ohio River & Electric Railway & Power Co	Ohio	183	183
O. L. K	do	2,250	2,250
Oneida & Western	Tennessee	18,081	18,081
Oregon Short Line	Wyoming	978,063	978,063
Oregon-Washington Railroad & Navigation Co	Washington	196,079	196,079
Pacific Coast	do	422,147	422,147

Bituminous coal loaded for shipment in the United States in 1922, by railroads and waterways, in net tons—Continued.

Route.	State.	Quantity. By State.	Quantity. Total for route.
Railroads—Continued.			
Pennsylvania (includes Ohio River & Western, Pittsburgh, Cincinnati, Chicago & St. Louis, and Wheeling Terminal).	Illinois	936,024	54,441,055
	Indiana	3,893,245	
	Ohio	6,106,018	
	Pennsylvania	42,327,000	
	West Virginia	1,178,768	
Peoria & Eastern	Illinois	285,753	285,753
Peoria & Pekin Union	do	467,222	467,222
Peoria, Hanna City & Western	do	342,473	342,473
Pere Marquette	Michigan	408,365	408,365
Peru, La Salle & Deer Park	Illinois	60,055	60,055
Pittsburgh & Lake Erie	Pennsylvania	2,949,135	2,949,135
Pittsburgh & Shawmut	do	1,235,782	1,235,782
Pittsburgh & Susquehanna	do	164,599	164,599
Pittsburgh & West Virginia	Ohio	920,255	2,055,108
	Pennsylvania	971,515	
	West Virginia	163,338	
Pittsburgh, Chartiers & Youghiogheny	Pennsylvania	459,125	459,125
Pittsburgh County Electric	Oklahoma	20,392	20,392
Pittsburgh, Harmony, Butler & Newcastle Electric	Pennsylvania	2,500	2,500
Pittsburgh, Lisbon & Western	Ohio	12,181	167,535
	Pennsylvania	155,354	
Pittsburgh, Shawmut & Northern	do	412,895	412,895
Preston	Maryland	13,690	100,201
	West Virginia	86,511	
Puget Sound Electric	Washington	20,089	20,089
Quincy, Omaha & Kansas City	Missouri	30,534	30,534
Reynoldsville & Falls Creek	Pennsylvania	139,959	139,959
Rio Grande & Eagle Pass	Texas	47,002	47,002
Rio Grande Southern	Colorado	44,535	44,535
Rock Island Southern	Illinois	68,908	68,908
St. Louis & Belleville Electric	do	288,612	288,612
St. Louis & Hannibal	Missouri	12,657	12,657
St. Louis & O'Fallon	Illinois	650,578	650,578
St. Louis & Ohio River	do	154,835	154,835
St. Louis & San Francisco	Alabama	2,741,478	4,850,284
	Arkansas	185,006	
	Kansas	975,428	
	Missouri	248,422	
	Oklahoma	699,950	
St. Louis Southwestern of Texas	Texas	111,028	111,028
St. Louis, Troy & Eastern	Illinois	794,335	794,335
San Antonio Southern	Texas	21,800	21,800
Sandy Valley & Elkhorn	Kentucky	1,482,340	1,482,340
Santa Fe, Raton & Eastern	New Mexico	172,219	172,219
Seaboard Air Line	Alabama	15,000	15,000
Sewell Valley	West Virginia	99,844	99,844
Southeastern Ohio	Ohio	704	704
Southern	Alabama	3,432,800	8,993,933
	Illinois	629,253	
	Indiana	1,207,982	
	Kentucky	493,693	
	Tennessee	1,678,715	
	Virginia	1,551,490	
Southern Illinois Railway & Power Co	Illinois	40,328	40,328
Southern Pacific	Oregon	17,011	17,011
Springfield Terminal	Illinois	284,300	284,300
Stout Mountain & Hanceville	Alabama	26,971	26,971
Strouds Creek & Muddlety	West Virginia	52,496	52,496
Susquehanna & New York	Pennsylvania	6,480	6,480
Tennessee	Tennessee	124,935	124,935
Tennessee Central	do	467,584	467,584
Tennessee Coal & Iron	Alabama	2,742,051	2,742,051
Texas & Pacific	Texas	120,382	120,382
Texas Short Line	do	52,450	52,450
Thomas & Sayreton	Alabama	498,597	498,597
Toledo & Ohio Central	Ohio	1,594,795	1,594,795
Toledo, Peoria & Western	Illinois	285,317	285,317
Toledo, St. Louis & Western	do	392,388	408,116
	Indiana	15,728	
Trinidad Electric	Colorado	24,364	24,364
Uintah	do	9,679	9,679
Union	Pennsylvania	570,686	570,686
Union Pacific	Colorado	980,574	4,369,624
	Kansas	20,136	
	Utah	69,259	
	Wyoming	3,299,655	

Bituminous coal loaded for shipment in the United States in 1922, by railroads and waterways, in net tons—Continued.

Route.	State.	Quantity.	
		By State.	Total for route.
Railroads—Continued.			
Unity	Pennsylvania	343,873	343,873
Ursina North Fork	do	31,015	31,015
Utah	Utah	1,660,415	1,660,415
Virginian	Virginia	10,132	6,969,425
	West Virginia	6,959,293	
Wabash	Illinois	2,146,612	2,566,089
	Iowa	250,681	
	Missouri	168,796	
Wabash, Chester & Western	Illinois	298,100	298,100
Washington Run	Pennsylvania	163,075	163,075
Western Allegheny	do	361,511	361,511
Western Maryland	Maryland	570,505	3,197,372
	Pennsylvania	701,517	
	West Virginia	1,925,350	
West Side Belt	Pennsylvania	683,739	683,739
West Virginia Midland	West Virginia	300	300
West Virginia Northern	do	369,879	369,879
Wheeling & Lake Erie	Ohio	3,013,920	3,013,920
Wichita Falls & Southern	Texas	3,757	3,757
Williamson & Pond Creek	Kentucky	44,757	44,757
Winfield	Pennsylvania	5,843	5,843
Winifrede	West Virginia	97,590	97,590
Woodstock & Blocton	Alabama	139,163	139,163
Woodward Iron Company	do	1,087,036	1,087,036
Wyoming	Wyoming	217	217
Youngstown & Ohio River	Ohio	332,893	332,893
Zanesville & Western	do	926,506	926,506
Total railroad shipments		374,390,041	374,390,041
Waterways.			
Allegheny River	Pennsylvania	394,701	394,701
Big Sandy River	West Virginia	740	740
Green River	Kentucky	38,439	38,439
Illinois River	Illinois	15,460	15,460
Kanawha River	West Virginia	322,909	322,909
Kentucky River	Kentucky	53,000	53,000
Monongahela River	Pennsylvania	7,851,617	7,851,617
Muskingum River	Ohio	5,314	5,314
Ohio River	Kentucky	254,140	482,999
	Ohio	43,344	
	Pennsylvania	5,806	
	West Virginia	179,709	
Tradewater River	Kentucky	4,000	4,000
Warrior River	Alabama	115,458	115,458
Miscellaneous waterways	Alaska	2,729	2,729
Total waterway shipments		9,287,366	9,287,366
Grand total		383,677,407	383,677,407

EXPORTS AND IMPORTS OF COAL.[8a]

IMPORTS.

Coal is a commodity of low value per unit of weight, and its distribution in world trade is governed more by the cost of transportation than by tariff regulations. The exigencies of supply and trade make the United States both an importer and an exporter of coal. Although the country as a whole has a large exportable surplus, there are areas in the far Northwest that depend on supplies from Canada.

Under normal conditions of trade and production the imports fluctuate but little from month to month or from year to year and

[8a] Statistics compiled from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

amount to about 1,300,000 tons annually. The normal imports consist almost entirely of bituminous coal from Vancouver Island and Alberta, received in Washington, Montana, and Idaho, and of small quantities of coal brought to the Pacific coast ports as ballast in vessels from Australia and Japan. At one time a considerable quant tity of coal was imported into New England from Nova Scotia, bu- in recent years that movement has been negligible. A very small quantity of anthracite from Vancouver is imported into Washington.

Occasionally a great strike creates a shortage in the United States severe enough to stimulate imports from Europe. That was what happened in 1922, when the total quantity of bituminous coal imported was 5,059,999 net tons, as compared with 1,257,589 tons in 1921, 1,244,990 tons in 1920, and 1,011,550 tons in 1919. Imports from the United Kingdom jumped to 3,289,087 tons, as compared with 28,728 tons in 1921 and 8,291 tons in 1920. The Middle Atlantic and New England States took this coal, also 202,718 tons of anthracite from Wales. The business done in 1922 has encouraged some interests in Great Britain to seek a permanent foothold in eastern North America. Imports from Asia declined in 1922, but there was a sharp increase in the receipts of bituminous coal from Australia, which also shipped 8,427 tons of anthracite.

Bituminous coal imported into the United States in 1919–1922, by countries and districts, in net tons.

Country of origin.	1919	1920	1921	1922
North America:				
Canada	924,138	1,123,903	1,092,132	1,555,038
Mexico	33	48	115	147
Newfoundland and Labrador		1,240		
Cuba				325
Dutch West Indies			221	
South America:				
Brazil		67	123	20
Chile	2			
Venezuela			2	129
Europe:				
Belgium	672	55	1	1,680
France		33	875	
Germany		314	225	2,894
Greece		280		
Italy	448		1	
Malta, Gozo, and Cyprus Islands	168			
Netherlands		84		
Sweden				44
United Kingdom—				
England	2,110	8,287	27,608	2,831,293
Scotland			1,120	
Ireland		4		457,794
Asia:				
China		3	1,667	6,588
Kwangtung, leased territory			8,760	
Dutch East Indies		392		
Hongkong			56	
Japan	7,411	28,408	50,191	15,428
Philippine Islands	552	2,240	201	1,230
Russia in Asia		17		134
Africa:				
Egypt			301	
French Africa	206			
Oceania:				
Australia	75,603	76,422	73,976	187,255
New Zealand	207	3,193	14	
	1,011,550	1,244,990	1,257,589	5,059,999

Bituminous coal imported into the United States in 1919–1922, by countries and districts, in net tons—Continued.

District of entry.	1919	1920	1921	1922
Maine and New Hampshire	24,043	59,781	26,078	356,721
Vermont	12	1,193	9	41,096
Massachusetts	318	6,357	301	1,645,087
Rhode Island				210,903
Connecticut				4,523
St. Lawrence	563	2,998	317	14,597
Buffalo		4,731	17	6,579
New York	1,878	16,215	1,939	1,148,142
Philadelphia	710			218,361
Pittsburgh		17		1
Maryland		448	3	89,589
Virginia	448	1,610		325
Georgia				90
Florida			28	
New Orleans	336		347	762
Galveston		224		2,520
San Antonio	33	48	87	147
San Diego			2,240	
Los Angeles				28
San Francisco	31,362	18,567	86,902	184,880
Oregon	76	4,595	4,205	16,794
Washington	289,527	275,824	348,034	455,363
Alaska	48,708	45,264	33,776	34,251
Hawaii	90,108	101,038	47,210	92,876
Montana-Idaho	519,419	697,174	702,707	506,179
Dakota	586	1,794	2,896	6,066
Duluth-Superior	1,603	5,357	272	17,740
Wisconsin				1,680
Michigan	1,820	1,755		2,918
Ohio				1,652
Porto Rico			221	129
	1,011,550	1,244,990	1,257,589	5,059,999

Anthracite imported into the United States in 1919–1922, by countries and districts, in net tons.

Country of origin.	1919	1920	1921	1922
Canada	81,205	30,853	6,654	21,220
Costa Rica		2		
Mexico	941	151		
Other British Indies		4		
Dutch West Indies	202	112		
Brazil			26	
Chile			1	
Peru		4	3	1
England	336	369	11	202,718
France			10	
Germany				901
Scotland	112			
Spain				34
China				3
Kwangtung, leased territory			9	
Chosen	22			
British India			6	
Japan		238	2,174	
British South Africa		1		
British West Africa				224
Australia		14		8,427
	82,818	31,748	8,894	233,528

Anthracite imported into the United States in 1919–1922, by countries and districts, in net tons—Continued.

District of entry.	1919	1920	1921	1922
Maine and New Hampshire	1,691	777	1,259	32,031
Vermont	3	221	30	532
Massachusetts				32,791
Rhode Island				26,967
St. Lawrence	65	17	35	54
Rochester				
Buffalo			46	
New York	336	627	67	74,525
Maryland				37,284
New Orleans				224
San Antonio	941	151		
San Francisco				9,547
Oregon				3
Washington	79,326	28,407	4,967	10,778
Alaska				1
Hawaii			2,173	
Montana and Idaho		112	40	
Dakota	69	439		311
Duluth-Superior	73	880	238	7,940
Michigan			39	540
Porto Rico	314	117		
	82,818	31,748	8,894	233,528

EXPORTS.

GENERAL FEATURES.

The exports of coal from the United States far exceed the imports. The quantity of anthracite normally exported is relatively constant, about 5,000,000 net tons a year. The exports of bituminous coal in recent years have ranged from 20,100,000 net tons in 1919 to 38,500,000 tons in 1920. In 1922 the strike at home and unfavorable conditions abroad pulled the total down to 12,400,000 net tons.

In considering exports the trade with Canada must be distinguished from that with other countries. The trade with other countries is sea-borne, except for small shipments to Mexico. It is relatively new, fluctuating, and at times speculative. The trade with Canada is stable and of long standing.

TRADE WITH CANADA.

Although Canada is richly endowed with low-rank bituminous coal and lignite, her fields of high-rank coals are confined to Nova Scotia in the east and British Columbia in the west. A great stretch of central Canada is without coal and has for many years depended upon the mines of the United States, normally purchasing about 4,500,000 net tons of anthracite and from 12,000,000 to 18,000,000 tons of bituminous coal. In this market the only serious competitor of American coal has been the product of the Canadian mines themselves. At those mines the wage rates are fixed by agreement with the United Mine Workers of America under contracts that are readjusted periodically according to the changes in the basic wage districts in the United States. The competition between coal mined in the United States and in Canada is therefore fairly constant in its relations. Probably no part of the coal trade of the United States proceeds

more steadily than the export movement to Canada. The coal is mined year after year in the same fields and moves to the same consumers and generally over the same transportation routes and through the same wholesale channels. The fluctuations in the quantity shipped to Canada from one year to the next are no greater than those in the domestic consumption of the United States, for the business conditions in both countries are as a rule nearly alike.

For these reasons the needs of Canada must be considered in framing any emergency program for the production and distribution of coal. Thus the budget of the Fuel Administration permitted shipments to Canada in the same ratio to estimated requirements that was allotted to the several States, and the Canadian Government cooperated by imposing the same regulations upon consumers in Canada that were in force in the United States. Again, in 1922, the distribution program adopted for anthracite after the strike placed Canada on the same basis as the States.

SEA-BORNE EXPORT TRADE.

In contrast to the trade with Canada, the sea-borne export trade of the United States is beset by many difficulties and uncertainties. In pre-war years it averaged about 4,000,000 net tons a year. The war at first stimulated but later curtailed exports as the activity of the submarines cut deeply into the world's supply of shipping. In 1919 offshore exports were 8,278,000 net tons. In 1920 the export demand was unprecedented and our sea-borne exports reached the enormous total of 22,059,000 net tons. The next year, in the face of a world-wide industrial depression, they dropped to 9,541,000 tons, and would have dropped still lower but for the fact that for three months exports from the United Kingdom were suspended by a strike in that country. In 1922 the sea-borne exports were only 1,475,000 net tons—a total that was less than the imports of bituminous coal from Canada that year and was equivalent to only 29.2 per cent of our total bituminous imports for the year. The strike in this country and greater competition from the United Kingdom explain the heavy decrease.

The accompanying tables show how sudden and extreme have been the fluctuations in sea-borne exports. It remains to be seen how much of the increase over pre-war trade American exporters will be able to retain in the face of the uncertainties of foreign exchange and ocean freights, the impaired buying power of foreign countries, and the competition of British and German coals.

Practically all our sea-borne exports consist of bituminous coal rather than anthracite, and the trade is largely confined to Hampton Roads, Baltimore, Philadelphia, and Charleston. New York plays little part in the export trade proper, but is one of the leading bunkering ports for vessels engaged in foreign commerce.

Bituminous coal exported from the United States in 1919–1922, by countries, in net tons.[a]

Country.	1919	1920	1921	1922
North America:				
Bermuda	21,771	54,939	36,738	15,968
British Honduras	673	493	780	1,900
Canada	11,949,829	16,230,202	13,396,774	10,836,347
Costa Rica	1,923	15,352	3,613	2,470
Guatemala	4,360	1,181	2,940	670
Honduras	9,360	14,619	15,837	6,512
Nicaragua	2,269	1,029	2,045	979
Panama	80,748	173,647	249,568	116,993
Salvador	2,512	3,502	44	34
Greenland	1,363	1,178	795	224
Mexico	113,880	227,598	192,876	101,983
Newfoundland and Labrador	4,712	28,445	5,466	2,388
West Indies—				
Barbados	120,551	82,276	22,135	20,904
Jamaica	37,059	92,338	65,690	31,028
Trinidad and Tobago	46,277	31,849	22,785	19,618
Other British West Indies	31,403	53,477	8,698	13,938
Cuba	1,087,967	1,492,548	587,521	519,521
Dominican Republic	15,333	12,611	9,456	7,893
Dutch West Indies	27,657	45,222	13,665	32,334
French West Indies	26,806	50,916	62,520	60,474
Haiti		1	80	3
Virgin Islands of the United States	17,188	47,456	26,566	15,683
	13,603,641	18,660,879	14,726,592	11,807,884
South America:				
Argentina	541,396	1,924,712	842,952	88,448
Brazil	710,202	1,080,821	590,492	170,389
Chile	104,852	553,416	168,945	52,546
Colombia	13,255	7,076	12,867	6,325
Ecuador	3,302	4,733	4,729	4,613
Falkland Islands	17,033	3,442		
Guiana—				
British	4,196	20,086	3,861	3,642
Dutch	1,121	3,244	2,757	2,129
Paraguay		7,778		
Peru	51,317	39,628	31,530	15,488
Uruguay	218,397	299,944	98,997	
Venezuela	556	3,164	1,724	26
	1,665,627	3,948,044	1,758,854	343,606
Europe:				
Austria		13,182		
Austria-Hungary	237			
Azores and Madeira Islands	36,799	53,360	90,278	
Belgium	224	307,524	26,554	
Czechoslovakia			7,529	
Denmark	99,571	1,082,647	171,307	3
Finland		31,229	920	
France	586,032	4,083,911	680,435	13,453
Germany	9,565	86,006	43,292	2,939
Gibraltar	22,726	92,222	141,420	
Greece	53,894	259,096	107,659	11,123
Hungary		5,817	8,292	
Iceland and Faroe Islands		8,010	15,551	
Italy	1,828,954	2,674,262	1,735,395	138,973
Malta, Gozo, etc			7,000	
Netherlands	808,854	2,404,581	374,180	2,841
Norway	179,024	824,623	47,582	
Poland and Danzig		7,573		
Portugal	50,599	184,144	112,200	1,421
Rumania		9,238	2	
Russia in Europe		69,119	97,819	
Spain	20,858	73,789	65,504	
Sweden	283,238	1,396,730	75,107	
Switzerland	592,004	909,812	9,810	
Turkey in Europe	4,710	105,728	21,456	
United Kingdom—				
England	7,379	36,133	1,138,474	162
Scotland		22,100	83,324	
Ireland			454,317	
	4,584,668	14,740,836	5,515,407	170,915

[a] Amounts stated do not include fuel or bunker coal loaded on vessels engaged in the foreign trade, which aggregated in 1919, 8,223,862 tons; in 1920, 10,485,639 tons; in 1921, 8,453,220 tons; and in 1922, 4,614,632 tons.

Bituminous coal exported from the United States in 1919–1922, by countries, in net tons—Continued.

Country.	1919	1920	1921	1922
Asia:				
Aden		17,773		
China		11	7,343	
Dutch East Indies	14,808	1,235	14,445	
Far Eastern Republic				12
Palestine and Syria			[b] 7,595	
Russia in Asia	3	6	45	9
Turkey in Asia		13,156	19,182	
	14,811	32,181	48,610	21
Africa:				
Algeria and Tunis				7,869
British Africa—				
West	4,658	3,979	7,439	34
South		728		
East	6,915	11,090		
Canary Islands	21,937	67,502	192,973	1,782
Egypt	42,048	701,716	533,344	58,372
French Africa	58,241	266,735	204,746	22,622
German Africa		7,164		
Italian Africa	5,786			
Morocco			336	
Portuguese Africa	49,159	36,308	66,284	
	188,744	1,095,222	1,005,122	90,679
Oceania:				
New Zealand	56,038	39,918	67,011	
Other British Oceania	6	4	11	
Philippine Islands			9,559	
Other Oceania	1			
	56,045	39,922	76,581	
Grand total	20,113,536	38,517,084	23,131,166	12,413,085

[b] Figures cover period July to December, 1921.

Bituminous coal exported from the United States in 1919–1922, by districts, in net tons.[a]

District.	1919	1920	1921	1922
Georgia	36,901	189,185	10,258	
Maine and New Hampshire	13,304	338	244	301
Connecticut				83
Maryland	1,923,423	4,933,385	1,644,217	103,741
Massachusetts	2,788	45	3,472	28
New York	32,790	283,414	69,038	8,756
Philadelphia	1,135,943	2,756,491	687,391	140,949
South Carolina	175,247	741,633	336,567	136,776
Virginia	4,681,488	12,755,689	6,740,444	1,124,511
Florida	45,434	268,432	129,446	53,434
Galveston		217	12	210
Mobile	6,971	108,310	19,028	16,298
New Orleans	17,716	47,153	19,776	9,750
Sabine	19	159	56	54
Arizona	43,505	38,254	26,992	22,317
El Paso	46,542	137,257	123,530	50,539
San Antonio	15,094	18,207	15,804	2,523
Alaska	987	17	50	195
Hawaii	6	48	11	
Los Angeles		49	7	
Oregon	2,421	392		
San Diego		174	180	199
San Francisco	124	1,185	587	5,852
Southern California	277			
Washington	4,738	11,693	16,228	13,105
Buffalo	2,457,114	3,605,285	3,277,863	3,013,742
Montana and Idaho			7,426	
Dakota	38,152	23,715	58,517	25,950
Duluth-Superior	48,873	90,836	119,120	62,152
Michigan	1,134,576	1,782,437	1,340,509	1,400,105
Wisconsin				112
Ohio	5,892,189	7,160,774	5,835,505	4,281,290
Rochester	546,735	1,006,625	468,800	505,475
St. Lawrence	1,763,756	2,481,550	2,149,468	1,427,060
Vermont	45,694	72,894	30,407	7,578
Porto Rico	729	1,241	213	
	20,113,536	38,517,084	23,131,166	12,413,085

[a] Amounts stated do not include fuel or bunker coal.

Anthracite exported from the United States in 1919–1922, by countries, in net tons.

Country.	1919	1920	1921	1922
North America:				
Bermuda	3,322	2,119	3,716	
British Honduras	1		690	
Canada	4,865,912	4,968,282	4,519,216	2,572,450
Costa Rica		2		2
Guatemala	57	655	110	184
Honduras	1,116	1,397		93
Nicaragua	172	225		100
Panama		949	1,795	11
Salvador		4	6	9
Mexico	4,993	18,266	49,820	6,408
Miquelon	412	100	293	138
Newfoundland and Labrador	13,681	16,947	17,245	5,903
West Indies—				
Barbados	340	685	291	151
Jamaica	6	109	2	22
Trinidad and Tobago	2	22		
Other British West Indies	440	364	2,776	416
Cuba	58,079	58,410	53,648	48,748
Dominican Republic	9,554	7,773	10,531	1,506
Dutch West Indies		336	444	
French West Indies		13,940		
Haiti	2	4	1	
	4,958,089	5,090,589	4,660,584	2,636,141
South America:				
Argentina	28	5,127	1,959	25
Bolivia		504		
Brazil	1,894	9,966	22	4
Chile	259	1,832	596	
Colombia	810	289	80	
Ecuador		964		
Guiana—				
British	34			
Dutch			34	
French				140
Peru	448	3,759		
Uruguay		90		
Venezuela	2	6	11	9
	3,475	22,537	2,702	178
Europe:				
Austria-Hungary	207			
Azores and Madeira Islands			30	
Belgium		8,453		
Denmark		35,463	3,920	9
Finland		822		
France	2,833	73,362	1,594	
Germany	22	352		34
Greece		10,662		
Italy	10,478	5,468	174	
Netherlands	2	48,746	1,278	520
Norway	2	20,595		
Portugal	50	1,590		
Spain	762		4,767	
Sweden	112	44,111		
Switzerland		30,754		
Turkey in Europe	225	5,154		
England		2	368	259
	14,693	285,534	12,131	822
Asia:				
Russia in Asia			448	
Turkey in Asia	113	1,228	101	
Philippine Islands	228			
	341	1,228	549	
Africa:				
British West Africa			136	
Canary Islands		1,105	1,266	
Egypt		2,747		12,314
Portuguese Africa		9		
Oceania (French)				2
		3,861	1,402	12,316
Grand total	4,976,598	5,403,749	4,677,368	2,649,457

Anthracite exported from the United States in 1919–1922, by districts, in net tons.

District.	1919	1920	1921	1922
Connecticut				34
Georgia	2			
Maine and New Hampshire	1,469	843	866	812
Maryland	2,733	939	4,087	12,314
Massachusetts	2,907	1,177	983	712
New York	79,502	245,529	147,700	66,391
Philadelphia	66,483	176,021	72,844	47,554
South Carolina	1,633			
Virginia	7,476	19,777	5,464	
Florida	1,475	6,980	30	547
Mobile				140
New Orleans	2,027	9,513		236
Galveston				1
Sabine	1	34	35	
Arizona	55	644	8,840	3,381
El Paso	988	2,465	496	1,667
San Antonio	3,149	14,254	40,153	1,211
Oregon	1	6,441		
Los Angeles		17	5	2
Southern California	169			
San Diego		62	54	65
San Francisco		132	66	143
Washington	392	1,197	1,206	137
Alaska				2
Buffalo	2,622,023	2,622,543	2,532,752	1,381,779
Dakota	5,311	7,763	26,582	10,190
Duluth-Superior	18,630	7,497	9,025	4,002
Michigan	594	1,569	3,230	3,827
Ohio	63,016	27,896	24,687	13,412
Rochester	576,595	616,258	427,467	273,842
St. Lawrence	1,496,211	1,610,429	1,350,470	819,021
Vermont	23,616	23,685	20,326	7,867
Porto Rico	140	84		168
	4,976,598	5,403,749	4,677,368	2,649,457

Anthracite and bituminous coal exported from the United States to Canada, Mexico, and all other countries, 1919–1922, in net tons.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total
1919.													
Anthracite:													
Canada	405,740	230,408	117,704	316,083	444,170	528,444	542,349	557,303	529,666	476,572	337,986	379,487	4,865,912
Mexico	306	170	462	664	113	382	229	396	1,130	495	178	468	4,993
Other countries	6,953	11,362	13,776	2,666	2,369	2,407	3,593	8,146	17,761	8,724	21,041	6,895	105,693
	412,999	241,940	131,942	319,413	446,652	531,233	546,171	565,845	548,557	485,791	359,205	386,850	4,976,598
Bituminous:													
Canada	861,023	500,000	395,229	562,173	1,218,589	1,602,430	1,498,681	1,498,208	1,581,407	1,622,438	375,918	233,734	11,949,830
Mexico	11,026	5,759	6,080	6,944	7,733	16,029	6,523	12,267	12,199	9,808	10,004	9,508	113,880
Other countries	480,501	259,995	219,212	339,346	374,949	822,246	765,267	1,128,297	1,453,295	1,654,602	413,366	138,750	8,049,826
	1,352,550	765,754	620,521	908,463	1,601,271	2,440,705	2,270,471	2,638,772	3,046,901	3,286,848	799,288	381,992	20,113,536
1920.													
Anthracite:													
Canada	326,527	285,553	430,139	371,300	304,039	544,704	665,218	521,890	332,712	456,239	339,180	390,781	4,968,282
Mexico	594	380	961	956	158	461	290	429	479	438	4,570	8,550	18,266
Other countries	15,676	19,119	38,944	17,142	6,264	28,220	72,678	99,756	31,071	41,041	29,507	17,803	417,201
	342,797	305,052	470,044	389,398	310,461	573,385	738,186	622,055	364,262	497,718	373,257	417,134	5,403,749
Bituminous:													
Canada	514,073	606,222	716,391	940,460	802,426	1,337,019	1,886,888	2,091,047	1,974,836	2,234,213	1,634,498	1,492,129	16,230,202
Mexico	6,941	12,615	17,580	19,093	7,976	7,842	18,686	20,153	17,748	23,023	24,128	51,812	227,597
Other countries	878,053	690,226	946,634	1,763,883	1,878,517	2,163,262	2,078,044	2,490,636	2,500,211	2,872,553	2,336,566	1,460,700	22,059,285
	1,399,067	1,309,063	1,680,605	2,723,436	2,688,919	3,508,123	3,983,618	4,601,836	4,492,795	5,129,789	3,995,192	3,004,641	38,517,084
1921.													
Anthracite:													
Canada	305,732	301,827	331,539	394,317	464,136	537,286	428,324	411,724	309,929	338,922	358,676	336,803	4,519,215
Mexico	2,012	8,508	4,536	6,792	5,602	2,502	1,320	3,066	2,849	2,342	744	2,546	49,819
Other countries	2,317	16,649	8,818	11,649	16,687	15,616	4,962	2,976	6,946	1,548	9,485	3,681	108,334
	324,061	326,984	344,893	412,758	486,425	555,404	434,606	417,766	319,724	342,812	368,905	343,030	4,677,368

Bituminous:													
Canada	1,319,219	704,323	662,544	813,224	1,259,155	1,581,997	1,466,050	1,477,378	1,158,994	1,259,684	997,574	696,632	13,396,774
Mexico	36,037	28,904	14,209	9,284	8,865	19,970	16,239	15,236	15,331	11,622	9,746	7,433	192,876
Other countries	1,163,006	676,483	613,308	793,754	1,532,399	2,110,287	1,485,699	405,887	182,678	218,634	200,943	158,438	9,541,516
	2,518,262	1,409,710	1,290,061	1,616,262	2,800,419	3,712,254	2,967,988	1,898,501	1,357,003	1,489,940	1,208,263	862,503	23,131,166
1922.													
Anthracite:													
Canada	245,567	292,854	305,705	121,085	62,434	43,700	16,884	31,678	97,910	448,281	485,768	420,584	2,572,450
Mexico	435	114	596	488	213	401	1,134	305	1,409	192	912	209	6,408
All other	4,923	14,926	23,822	832	5,516	1,017	684	165	11	5,126	6,801	6,776	70,599
	250,925	307,894	330,123	122,405	68,163	45,118	18,702	32,148	99,330	453,599	493,481	427,569	2,649,457
Bituminous (not including fuel or bunker coal):													
Canada	589,138	740,091	1,091,240	507,814	304,804	479,191	324,809	418,420	1,244,089	1,845,002	1,750,540	1,541,209	10,836,347
Mexico	8,039	5,885	8,836	18,163	12,228	6,649	7,184	6,778	5,327	7,894	5,245	9,755	101,983
All other	124,006	165,241	229,715	274,817	130,465	119,576	78,248	51,396	66,592	84,060	56,416	94.223	1,474,755
	721,183	911,217	1,329,791	800,794	447,497	605,416	410,241	476,594	1,316,008	1,936,956	1,812,201	1,645,187	12,413,085
Fuel or bunker coal loaded on vessels engaged in foreign trade:	424,093	401,569	464,746	449,313	470,944	409,116	360,351	291,657	291,528	330,000	371,440	349,875	4,614,632

WORLD'S PRODUCTION OF COAL.

The world's production of coal in 1922, though greater than in 1921, was still less than in the years just preceding the World War. The total output in 1922 is placed at 1,223,000,000 metric tons, an increase of 89,000,000 tons over 1921 but a decrease of 119,000,000 tons when compared with 1913. The decline below the pre-war level is the more remarkable when it is remembered that the world's consumption of coal normally increases by leaps and bounds. In the 20 years preceding August, 1914, the average annual increase was 38,000,000 tons. Even when allowance is made for the substitution of fuel oil for coal, there is probably no fact that speaks more eloquently of the economic disorganization wrought by the war than this decline in the production of coal.

But while the production of Europe was declining, that of the United States continued to increase, though less rapidly than formerly. In consequence, the percentage of the world total contributed by the United States has been rising. From 38.6 per cent of the world total in 1913, the share of the United States rose to 46.3 per cent in 1918 and 45.3 per cent in 1920, and even during the depression of 1921 it exceeded the 40 per cent mark.

In 1922, however, because of the double strike in both the anthracite and bituminous mines, production of the United States dropped to 35.4 per cent of the total, the lowest proportion for many years.

World's production of coal, 1910–1922.

Year.	Production in part estimated (metric tons).	Percentage produced by United States.	Year.	Production in part estimated (metric tons).	Percentage produced by United States.
1910	1,160,000,000	39.2	1917	1,356,000,000	43.6
1911	1,189,000,000	37.9	1918	1,333,000,000	46.3
1912	1,249,000,000	38.8	1919	1,173,000,000	42.8
1913	1,342,000,000	38.6	1920	1,319,000,000	45.3
1914	1,207,000,000	38.7	1921	1,134,000,000	40.5
1915	1,193,000,000	40.5	1922	1,223,000,000	35.4
1916	1,291,000,000	41.5			

For a discussion of the producing coal fields and markets of the several countries the reader is referred to the United States Geological Survey's "World Atlas of Commercial Geology, Part I, Distribution of mineral production." Only the statistics of output are presented here. The following table has been compiled from the official reports of the several countries, supplemented by trade information, by W. I. Whiteside, under the direction of B. L. Johnson.

The unit of measurement is the metric ton of 2,204.6 pounds, which can best be remembered by the American reader as roughly equivalent to the long or gross ton. The term "coal" as used by the Geological Survey includes lignite, and the production for the world is simply the total of the quantities reported, no attempt being made to reduce the statistics for inferior coals to an equivalent tonnage of coals of higher rank. Where possible, however, lignite is shown separately.

Coal produced in the principal countries of the world, 1919–1922.

[In metric tons of 2,204.6 pounds.]

Country.	1919	1920	1921	1922
North America:				
Canada: Coal	9,958,682	12,020,531	10,684,259	10,587,611
Lignite	2,668,444	3,353,234	2,975,598	3,162,907
Greenland	2,160	2,308	2,200	2,100
Mexico	693,866	[a]	731,022	949,677
United States: Anthracite	79,915,482	81,282,000	82,076,000	49,607,344
Bituminous and lignite	422,618,927	515,883,000	377,316,000	383,073,174
South America:				
Argentina	[a]	[a]	[a]	[a]
Brazil	[a]	[a]	[a]	500,000
Chile	1,485,491	1,063,185	1,275,117	1,053,001
Colombia	[a]	[a]	[a]	[a]
Peru	330,227	361,075	345,481	249,492
Venezuela	33,287	30,377	[b] 22,094	[b] 20,782
Europe:				
Austria: Coal	90,472	132,864	137,633	165,727
Lignite	2,006,773	2,408,865	2,478,862	3,135,902
Belgium	18,482,880	22,388,770	21,750,410	21,208,500
Bulgaria	577,739	757,250	939,586	1,030,036
Czechoslovakia: Coal	10,254,233	11,380,443	11,648,399	9,906,261
Lignite	17,323,961	19,957,547	21,050,712	18,942,920
France: Coal	21,546,487	24,293,223	28,211,839	31,163,032
Lignite	894,894	967,835	748,634	777,813
Germany: Coal	116,707,234	131,355,964	136,227,231	[c] 129,964,597
Lignite	93,648,264	111,887,694	123,010,036	137,207,125
Saar	[d]	9,410,433	9,574,484	11,240,000
Greece	182,951	197,454	168,576	131,515
Hungary	3,901,720	4,963,060	6,417,960	7,717,610
Italy: Coal	23,681	151,862	114,236	195,352
Lignite	1,123,297	1,571,735	1,026,035	745,402
Netherlands: Coal	3,540,064	4,115,629	4,243,000	4,866,371
Lignite	1,881,962	1,395,851	421,715	28,919
Poland	6,083,700	6,660,145	7,842,533	[e] 24,194,797
Portugal	146,341	169,165	135,732	[a]
Rumania	1,559,330	1,587,575	1,804,687	2,116,221
Russia	6,463,000	6,067,300	7,550,800	7,781,400
Spain: Coal	5,703,637	5,420,704	5,012,229	4,435,843
Lignite	539,872	552,425	408,674	329,680
Spitsbergen	90,000	130,000	210,000	316,000
Sweden	429,267	439,584	376,692	378,861
Switzerland	64,902	74,590	10,714	3,380
United Kingdom:				
Great Britain	233,373,581	233,106,377	165,781,404	253,613,054
Ireland	93,897	109,845	89,958	[a]
Yugoslavia	2,496,233	3,412,361	3,063,198	3,726,568
Asia:				
British India	22,991,217	18,250,508	19,612,759	19,316,112
China	23,000,000	19,484,896	19,876,375	21,300,000
Chosen	223,078	293,675	310,590	317,330
Federated Malay States	194,363	251,896	304,156	286,351
Indo-China	665,149	700,267	920,900	988,991
Japan (including Taiwan and Karafuto) [f]	32,504,296	30,550,625	27,375,367	29,150,000
Russia	1,836,000	1,544,600	1,363,800	1,276,900
Turkey	481,331	[g] 700,000	[a]	[a]
Africa:				
Algeria	7,419	7,793	9,541	8,855
Belgian Congo		2,000	2,990	33,000
Nigeria	140,057	183,013	216,262	123,027
Rhodesia, Southern	462,698	524,796	521,404	467,787
Tunis	36,551	31,331	22,207	343
Union of South Africa	9,313,232	10,408,497	10,339,044	8,830,774
Oceania:				
Australia:				
New South Wales	8,770,090	10,887,991	10,966,621	10,346,572
Queensland	946,584	1,127,727	970,087	973,903
Tasmania	67,316	76,640	67,543	70,349
Victoria	544,170	614,632	603,618	660,113
Western Australia	408,160	469,436	476,341	445,480
British Borneo	118,788	[a]	[a]	88,948
Dutch East Indies	949,670	1,095,718	1,212,665	1,032,310
New Zealand	1,877,506	1,873,296	1,838,131	1,887,637
Philippine Islands	32,892	58,888	39,445	[a]
	1,172,900,000	1,319,300,000	1,134,000,000	1,223,000,000

[a] Estimate included in total.

[b] Exclusive of the production of the State of Falcon (about 8,000 tons), for which estimate is included in total.

[c] Includes entire output of Upper Silesia for January–May, for June–December only that part of Upper Silesia allocated to Germany.

[d] Included with Germany. The production for 1919 was 8,990,000 tons.

[e] Includes for June–December that part of Upper Silesia awarded to Poland.

[f] Exclusive of lignite from Japan (annual production of about 200,000 tons), for which estimate is included in the total.

[g] Based on incomplete data.

The figures given in the preceding table for the belligerent nations correspond to the boundaries established by the treaties of peace. The statistics in the following table, on the contrary, correspond to the boundaries in existence in 1913. The table is included to complete the statistical record of foreign production formerly carried in these reports but discontinued after 1914 because of the war.

Coal produced in the principal countries of the world, 1913–1918.

[In metric tons of 2,204.6 pounds.]

Country.	1913	1914	1915	1916	1917	1918
North America:						
Canada: Coal			10,417,866	11,078,547	10,217,093	10,660,812
Lignite	13,618,748	12,371,694	1,617,712	2,060,500	2,525,846	2,926,863
Greenland	[a]	[a]	[a]	[a]	1,780	1,470
Mexico	[a]	[a]	[a]	[a]	430,700	430,820
United States	517,056,511	465,860,042	482,274,566	535,325,262	590,939,207	615,260,275
South America:						
Argentina		285	1,848	913	1,215	4,784
Brazil	[a]	[a]	[a]	[a]	[a]	[a]
Chile	1,283,450	1,086,946	1,171,564	1,418,119	1,539,314	1,516,524
Colombia	[a]	[a]	[a]	[a]	[a]	[a]
Peru	[b] 273,945	[b] 283,860	[b] 290,743	306,983	345,464	331,311
Venezuela	[c] 6,322	8,896	13,768	18,583	20,165	25,332
Europe:						
Austria: Coal[d]	16,459,889	15,546,455	16,083,075	17,601,708	16,729,172	14,310,527
Lignite	27,378,332	23,580,738	22,071,151	23,199,895	21,625,949	18,110,848
Bosnia-Herzegovina	805,757	806,605	798,669	927,985	972,943	931,658
Belgium	22,841,590	16,714,050	14,177,500	16,862,870	14,931,340	13,891,400
Bulgaria: Coal	10,220	12,551	18,502	16,132	19,052	26,272
Lignite	347,525	408,620	515,263	623,681	742,221	646,609
France: Coal	40,050,888	26,840,911	18,855,544	20,541,595	27,757,411	24,941,182
Lignite	793,330	687,198	677,388	768,478	1,157,996	1,317,901
Germany: Coal	190,109,440	161,384,711	146,867,563	159,169,666	167,747,171	158,254,116
Lignite	87,233,084	83,693,647	87,948,303	94,180,462	95,542,922	100,599,318
Greece	170	20,002	39,745	116,946	157,956	213,428
Hungary: Coal	1,319,919	1,115,837	1,097,255		1,221,423	
Lignite	8,954,133	8,058,829	8,163,617	[a]	7,610,052	[a]
Iceland	[a]	[a]	[a]	[a]	1,980	2,350
Italy: Coal	1,120	1,440	9,314	18,544	45,444	32,332
Lignite	697,319	778,308	939,027	1,282,819	1,656,963	2,117,145
Netherlands: Coal	1,873,079	1,928,540	2,262,148	2,656,087	3,007,925	3,399,512
Lignite					42,442	1,483,609
Portugal	25,400	29,500	39,600	[a]	[a]	[a]
Rumania	240,731	272,703	308,952	[a]	[a]	[a]
Russia	33,814,060	33,189,157	30,651,000	36,014,000	33,402,000	14,683,000
Serbia	311,365	[a]	[a]	[a]	[a]	252,000
Spain: Coal	4,015,731	4,133,382	4,358,540	4,847,475	5,042,213	6,512,202
Lignite	276,791	291,057	328,213	473,106	637,841	726,348
Spitsbergen	35,000	40,000	28,000	20,000	40,000	60,000
Sweden	363,965	366,639	412,261	414,825	442,633	404,494
Switzerland			[a]	[a]	[a]	116,000
Turkey	[e]	[e]	[e]	[e]	[e]	[e]
United Kingdom	292,043,814	269,928,611	257,271,850	260,490,699	252,488,567	231,404,172
Asia:						
British India	16,468,148	16,728,514	17,378,450	17,531,241	18,505,235	21,055,089
China	13,779,000	9,272,000	18,000,000	21,700,000	[a]	[a]
Chosen	127,989	183,262	229,121	190,760	195,140	187,623
Federated Malay States			11,708	103,481	157,771	171,448
Indo-China	430,256	620,000	643,900	685,320	653,910	636,000
Japan (includes Taiwan and Karafuto)[f]	21,637,972	22,653,836	20,901,219	23,460,957	27,098,570	28,943,732
Russia	2,162,213	2,453,784	2,247,000	3,499,000	4,207,000	2,016,000
Turkey	[c] 865,603	[c] 661,072	[c] 530,106	[c] 496,900	[c] 376,833	[c] 362,828

[a] Estimate included in total.
[b] Includes small quantity "asfaltita."
[c] Average annual production, 1911–1913.
[d] Exclusive of Bosnia-Herzegovina, which is shown separately.
[e] Turkey in Europe included under Turkey in Asia.
[f] Exclusive of lignite from Japan (annual production of about 200,000 tons), for which estimate is included in total.

Coal produced in the principal countries of the world, 1913–1918—Continued.

Country.	1913	1914	1915	1916	1917	1918
Africa:						
Algeria: Lignite					2,235	7,018
Nigeria				25,401	84,332	150,375
Rhodesia, Southern	220,742	317,022	371,729	445,953	498,000	445,669
Tunis: Lignite				10,621	32,682	46,305
Union of South Africa	7,984,287	7,691,002	7,512,652	9,078,606	9,419,177	8,960,511
Oceania:						
Australia	12,617,173	12,644,607	11,598,669	9,971,603	10,400,964	11,125,083
British Borneo	99,491	101,020	117,042	110,650	116,502	115,232
Dutch East Indies	567,626	621,337	619,010	748,815	832,129	833,082
New Zealand	1,915,872	2,238,961	2,244,072	2,293,362	2,101,617	2,066,900
Philippine Islands					5,478	15,663
	1,342,300,000	1,207,200,000	1,193,200,000	1,291,000,000	1,356,000,000	1,333,400,000

PRODUCTION OF COAL, BY STATES.

ALABAMA.

Every county in Alabama but Winston showed an increase in production in 1922. The output for the State as a whole was 18,324,740 tons, valued at $42,856,000. Compared with 1921 this was an increase of 5,755,841 tons, or 45.8 per cent, in quantity, and $4,143,000, or 10.7 per cent, in value. The number of days the mines were in operation increased from 166 to 215, the highest average reported among the major coal-producing States. The greatest increase in quantity—2,320,392 tons—was in Jefferson County; Walker County came next, with an increase of 1,877,395 tons. The average value per ton dropped from $3.08 to $2.34. The total number of men employed increased 2,360; of this number 390 were surface employees.

Coal produced in Alabama in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
								Miners.[a]	All others.			
1921.[b]												
Bibb	616,709	6,112	21,171	----------	643,992	$2,277,000	$3.54	1,009	426	280	1,715	150
Blount	298,712	1,878	1,800	----------	302,390	1,073,000	3.55	437	62	136	635	177
Etowah	72,869	765	1,473	----------	75,107	233,000	3.10	147	35	44	226	172
Jefferson	5,585,362	91,138	167,338	20,637	5,864,475	17,385,000	2.96	6,468	3,067	1,757	11,292	173
St. Clair	622,355	5,029	18,828	----------	646,212	2,123,000	3.28	509	202	124	835	203
Shelby	429,614	7,670	23,212	----------	460,496	1,903,000	4.13	681	227	181	1,089	192
Tuscaloosa	411,514	7,209	11,958	107,721	538,402	1,624,000	3.02	1,053	340	229	1,622	129
Walker	3,685,128	191,487	43,269	----------	3,919,884	11,670,000	2.98	4,816	1,450	1,827	8,093	158
Winston	33,150	----------	----------	----------	33,150	86,000	2.59	89	32	25	146	181
Other counties[c]	79,196	1,837	3,758	----------	84,791	339,000	4.00	95	28	33	156	142
	[d]11,834,609	313,125	292,807	128,358	12,568,899	38,713,000	3.08	15,304	5,869	4,636	25,809	166
1922.												
Bibb	1,014,072	5,259	20,358	----------	1,039,689	2,591,000	2.49	1,106	482	321	1,909	203
Blount	313,767	1,930	5,263	----------	320,960	807,000	2.51	463	70	115	648	176
Etowah	95,042	2,319	1,449	----------	98,810	227,000	2.30	166	20	33	219	228
Jefferson	7,790,054	109,907	161,470	123,436	8,184,867	18,866,600	2.31	6,568	3,297	1,845	11,710	229
St. Clair	779,952	4,310	19,035	----------	803,297	1,898,000	2.36	616	175	131	922	252
Shelby	596,334	12,297	18,510	----------	627,141	1,901,000	3.03	882	334	238	1,454	205
Tuscaloosa	966,227	19,952	16,339	174,246	1,176,764	2,271,000	1.93	984	362	234	1,580	259
Walker	5,553,635	201,742	41,902	----------	5,797,279	13,502,000	2.33	5,539	1,710	2,021	9,270	195
Winston	27,795	585	----------	----------	28,380	79,000	2.79	75	23	21	119	124
Other counties[e]	142,882	2,510	5,861	----------	151,253	426,400	2.82	216	55	67	338	169
Total, excluding wagon mines	[d]17,279,760	360,811	290,187	297,682	18,228,440	42,569,000	2.34	16,615	6,528	5,026	28,169	215
Wagon mines served by rail	96,300	----------	----------	----------	96,300	287,000	2.98	----------	----------	----------	----------	----------
Grand total	17,376,060	360,811	290,187	297,682	18,324,740	42,856,000	2.34	----------	----------	----------	----------	----------

[a] Includes also loaders and shot firers.
[b] Exclusive of product of wagon mines.
[c] Cullman and Marion
[d] Includes coal for by-product coke ovens transported over private railroads.
[e] Cullman, Franklin, and Marion.

Coal produced in Alabama in 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Bibb	1,374,548	1,034,099	968,011	643,992	1,039,689	+395,697
Blount	315,095	283,606	285,384	302,390	320,960	+18,570
Cullman and Marion	[a] 140,600	119,390	121,886	84,791	[a] 151,253	+[a] 66,462
Etowah	130,538	91,397	76,568	75,107	98,810	+23,703
Jefferson	9,379,957	7,548,567	7,719,910	5,864,475	8,184,867	+2,320,392
St. Clair	832,348	668,304	662,209	646,212	803,297	+157,085
Shelby	744,111	562,863	586,996	460,496	627,141	+166,645
Tuscaloosa	1,032,705	872,778	914,183	538,402	1,176,764	+638,362
Walker	5,156,269	4,290,298	4,768,457	3,919,884	5,797,279	+1,877,395
Winston	76,527	65,006	36,495	33,150	28,380	−4,770
Small mines	2,264	413	154,000	[b]	96,300	[b]
Total value	19,184,962	15,536,721	16,294,099	12,568,899	18,324,740	+5,755,841
	$54,752,329	$45,937,681	$59,410,000	$38,713,000	$42,856,000	+$4,143,000

[a] Includes Jackson County in 1918 and Franklin County in 1922.
[b] No canvass of wagon mines for 1921.

ALASKA.

The coal mined in Alaska in 1922 amounted to 79,275 tons, valued at $431,000, as compared with 76,817 tons, valued at $496,000, in 1921. During the year mining for the territorial market was continued in the Matanuska, Nenana, and Cook Inlet fields and in a very small way in some other places. Most of the coal produced was taken from the Evan Jones mine, in the Matanuska field, and the Healy mine, in the Nenana field. Work was temporarily suspended at the Evans Jones mine in November because of a fire. The Healy mine was worked until August, when operations were suspended because the company decided to develop property on the other side of the Nenana, where rail connections were made late in the fall. The Naval Coal Commission discontinued its exploratory work in the Matanuska field. Several thousand tons of coal was cleaned at the Government washery and shipped from this field for use in a naval steaming test.

The following table shows the production of coal in Alaska since 1888. The figures for 1888 to 1896 are estimates. Nearly all the coal mined before 1916 was lignite. The table does not include 855 tons mined in the Bering River field in 1912 and 1,100 tons mined in the Matanuska field in 1913 for test by the United States Navy.

Coal produced in Alaska, 1888–1922.

Year.	Net tons.	Value.	Year.	Net tons.	Value.	Year.	Net tons.	Value.
1888–1896	6,000	$84,000	1905	3,774	$13,250	1914		
1897	2,000	28,000	1906	5,541	17,974	1915	1,400	$3,300
1898	1,000	14,000	1907	10,139	53,600	1916	13,073	52,317
1899	1,200	16,800	1908	3,107	14,810	1917	53,955	265,317
1900	1,200	16,800	1909	2,800	12,300	1918	75,606	411,850
1901	1,300	15,600	1910	1,000	15,000	1919	60,674	343,547
1902	2,212	19,048	1911	900	9,300	1920	61,111	356,000
1903	1,447	9,782	1912	355	2,840	1921	76,817	496,000
1904	1,694	7,225	1913	2,300	13,800	1922	79,275	431,000

The following table shows the quantity of coal consumed in Alaska, including both local production and imports, since 1899. Most of the coal shipped to Alaska was bituminous, but a little was anthracite.

Coal consumed in Alaska, 1899–1922, in net tons.

Year.	Produced in Alaska, chiefly subbituminous and lignite.	Imported from States, chiefly bituminous from Washington.	Total foreign coal, chiefly bituminous from British Columbia.	Total coal consumed.
1899	1,200	10,000	[a] 50,120	61,320
1900	1,200	15,048	[a] 56,623	72,871
1901	1,300	24,000	[a] 77,674	102,974
1902	2,212	40,000	[a] 68,363	110,575
1903	1,447	64,626	[a] 60,605	126,678
1904	1,694	36,689	[a] 76,815	115,198
1905	3,774	67,713	[a] 72,612	144,099
1906	5,541	69,493	[a] 47,590	122,624
1907	10,139	46,246	[a] 93,262	149,647
1908	3,107	23,893	[a] 86,404	113,404
1909	2,800	33,112	69,046	104,958
1910	1,000	32,098	58,420	91,518
1911	900	32,255	61,845	95,000
1912	355	27,767	68,316	96,438
1913	2,300	69,066	56,430	127,796
1914	----------	41,509	46,153	87,662
1915	1,400	46,329	29,457	77,186
1916	13,073	44,934	53,672	111,679
1917	53,955	58,116	56,589	168,660
1918	75,606	51,520	37,986	165,112
1919	60,674	57,166	48,708	166,548
1920	61,111	38,128	45,264	144,503
1921	76,817	24,278	33,776	134,871
1922	79,275	28,457	27,021	134,753
	460,880	982,443	1,382,751	2,826,074

[a] Fiscal year ending June 30.

ARKANSAS.

The production of coal in Arkansas dropped from 1,227,777 tons, valued at $5,360,000, in 1921 to 1,110,046 tons, valued at $4,592,000, in 1922. The decline in quantity was 117,731 tons, or 9.6 per cent, and in value $768,000, or 14.3 per cent. The average value per ton declined from $4.37 to $4.14. The average number of days the mines worked during the year was only 81—the lowest average among all the coal-producing States. In 1921 the average was 112 days. Arkansas suffered heavily during the strike; at least 96 per cent of the productive capacity of the State was closed. Sebastian County showed the greatest loss in output—134,220 tons. Johnson County, on the other hand, reported an increase of 73,539 tons.

Coal produced in Arkansas in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Franklin	157,876	1,139	5,031	164,046	610,000	3.72	245	95	57	397	108
Johnson	57,576	318	898	58,792	253,000	4.30	250	96	82	428	48
Logan	64,495	9,429	1,038	74,962	422,000	5.63	185	68	29	282	139
Sebastian	801,506	2,218	23,097	826,821	3,334,000	4.03	1,470	485	217	2,172	117
Other counties[c]	93,131	6,373	3,652	103,156	741,000	7.18	165	104	68	337	149
	1,174,584	19,477	33,716	1,227,777	5,360,000	4.37	2,315	848	453	3,616	112
1922.											
Franklin	161,232	1,557	5,865	168,654	641,000	3.80	314	97	140	551	80
Johnson	125,478	3,528	3,325	132,331	638,000	4.82	341	153	197	691	65
Logan	57,212	1,580	1,069	59,861	418,000	6.98	231	87	34	352	113
Sebastian	671,897	5,372	15,332	692,601	2,521,000	3.64	1,379	604	285	2,268	81
Other counties[d]	26,932	3,075	2,592	32,599	270,000	8.28	121	32	20	173	93
Total, excluding wagon mines	1,042,751	15,112	28,183	1,086,046	4,488,000	4.13	2,386	973	676	4,035	81
Wagon mines served by rail	24,000			24,000	104,000	4.35					
Grand total	1,066,751	15,112	28,183	1,110,046	4,592,000	4.14					

[a] Includes also loaders and shot firers.
[b] Exclusive of product of wagon mines.
[c] Pope and Washington.
[d] Pope, Scott, and Washington

Coal produced in Arkansas, 1918–1922, in net tons.

Country.	1918	1919	1920	1921	1922	Increase or decrease, 1922
Franklin	240, 149	144, 541	278, 450	164, 046	168, 654	+4, 608
Johnson	371, 704	211, 036	257, 517	58, 792	132, 331	+73, 539
Logan	49, 368	42, 937	66, 636	74, 962	59, 861	−15, 101
Pope, Scott, and Washington	[a] 112, 692	[a] 118, 061	126, 528	[a] 103, 156	32, 599	−70, 557
Sebastian	1, 447, 268	903, 414	1, 321, 465	826, 821	692, 601	−134, 220
Small mines	6, 188	9, 031	53, 000	[b]	24, 000	[b]
Total value	2, 227, 369 $8, 172, 376	1, 429, 020 $5, 288, 844	2, 103, 596 $9, 592, 000	1, 227, 777 $5, 360, 000	1, 110, 046 $4, 592, 000	−117, 731 −$768, 000

[a] No production in Washington County in 1918 and 1919; no production in Scott County in 1921.
[b] No canvass of wagon mines for 1921.

CALIFORNIA, IDAHO, NEVADA, AND OREGON.

In three States of the Far West—California, Idaho, and Nevada—the number of coal producers is so small that the statistics can not be shown separately without disclosing the operations of individual companies. The statistical record of the three States combined is shown in the following table. For 1921 and 1922 it has been necessary to include figures for Oregon also. No production has been reported from Nevada since 1914. The inclusion of Oregon in the last two years and the elimination of Nevada in 1914 make it impossible to compare the totals for the years shown in the table.

Coal produced in California in 1911–1913, in California, Idaho, and Nevada in 1914 and 1915, in California and Idaho in 1916–1920, in California, Idaho, and Oregon in 1921 and 1922.

Year.	Net tons.				Value.		Number of employees.	Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.		
1911	4, 981	5, 266	500	10, 747	$16, 097	$1. 50	45	254
1912	3, 748	3, 630	3, 600	10, 978	23, 601	2. 15	52	184
1913	14, 864	1, 808	8, 167	24, 839	84. 073	3. 38	35	332
1914	4, 200	9, 174	600	13, 974	39, 821	2. 85	43	291
1915	2, 488	9, 715	300	12, 503	32, 054	2. 56	36	285
1916	1, 593	4, 647	1, 000	7, 240	15, 367	2. 12	18	183
1917	2, 800	3, 383	240	6, 423	14, 791	2. 30	17	173
1918	5, 800	600	----------	6, 400	17, 250	2. 70	15	240
1919	2, 448	3, 591	515	6, 554	22, 174	3. 38	77	59
1920	208	2, 540	5	2, 753	12, 000	4. 23	10	181
1921	19, 015	13, 305	6, 525	38, 845	181, 000	4. 66	141	149
1922	17, 011	3, 662	6, 220	26, 893	104, 000	3. 87	60	250

COLORADO.

Colorado, which is the largest coal-producing State west of the Mississippi River, made an output of 10,019,597 tons valued at $31,701,000, in 1922, as compared with 9,122,760 tons, valued at $32,377,000, in 1921. This was an increase of 896,837 tons, or 9.8 per cent, in quantity, but a decrease of $676,000, or 2.1 per cent, in value. The average value per ton declined from $3.55 to $3.16.

The increase in output was by no means evenly distributed. Boulder, Fremont, and Routt counties lost heavily, production in Routt County dropping from 880,015 to 432,198 tons. The heaviest increases were in El Paso, Huerfano, Las Animas, and Weld counties.

There was a decrease of 1,023 in the total number of employees; of this number 186 were surface employees. The average number of days the mines in the State as a whole operated increased from 164 to 191, but the average number in the different coal-producing counties varied widely. Routt County mines averaged only 51 days; Huerfano and Las Animas counties, which led in output, averaged 224 and 212 days, respectively; and Jefferson County, 265 days. According to the weekly reports furnished by the State operators association over 60 per cent of the productive capacity of the association was cut off by the strike during the first week in April, but the force of the blow was soon spent. During the second week the percentage dropped to 32.1, by the middle of May it had fallen to 15.1, and by the end of June it was less than 5.

Coal produced in Colorado in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
								Miners.[a]	All others.			
1921.[b]												
Boulder	758,370	46,610	46,706		851,686	$2,573,000	$3.02	615	325	178	1,118	166
Delta	69,735	20,200			89,935	259,000	2.88	58	14	25	97	147
Elbert, Jackson, and Jefferson	167,897	4,829	8,301		181,027	563,000	3.11	136	57	42	235	177
El Paso	159,950	122,232	6,349		288,531	847,000	2.93	192	68	67	327	155
Fremont	535,898	47,991	6,932		599,821	2,695,000	4.56	803	302	201	1,306	165
Garfield	6,962	9,833			16,795	68,000	4.05	14	3	3	20	188
Gunnison	445,993	4,704	28,310		479,007	1,728,000	3.61	378	170	174	722	154
Huerfano	1,718,620	16,331	20,799		1,755,750	7,174,000	4.09	1,634	725	629	2,988	192
La Plata	75,879	12,568	704	10,502	99,653	316,000	3.17	99	43	28	170	157
Las Animas	2,593,320	35,342	48,940	50,111	2,727,713	9,179,000	3.36	3,050	1,166	796	5,012	157
Mesa	96,461	14,700	2,600		113,761	407,000	3.58	110	39	41	190	158
Moffat, Montezuma, Ouray, Pitkin, and Rio Blanco		10,992			10,992	42,000	3.82	18	4	3	25	182
Routt	826,207	8,968	53,840		889,015	3,718,000	4.18	728	233	260	1,221	104
Weld	953,321	44,516	30,237		1,028,074	2,808,000	2.73	621	301	176	1,098	184
	8,408,613	[c] 399,816	253,718	60,613	[c] 9,122,760	32,377,000	3.55	8,456	3,450	2,623	14,529	164

1922.												
Boulder	644,461	48,974	35,508		728,943	2,180,000	2.95	698	266	232	1,196	167
Delta	80,447	24,726	30		105,203	339,000	3.19	77	19	25	121	143
Elbert, Jackson, and Pitkin	59,107	5,482	1,503		66,092	245,000	3.71	43	15	22	80	183
El Paso	219,668	158,167	11,568		389,403	1,068,000	2.74	242	75	71	388	226
Fremont	388,310	79,430	10,462		478,202	2,043,000	4.27	615	248	135	998	167
Garfield	10,129	9,549	100		19,778	66,000	3.34	16	3	4	23	234
Gunnison	405,463	5,348	26,711		437,522	1,334,000	3.05	255	128	124	507	196
Huerfano	2,026,743	28,104	14,503		2,069,350	7,536,000	3.64	1,437	620	496	2,553	224
Jefferson	169,430	3,257	7,860		180,547	412,000	2.29	100	48	25	173	265
La Plata	45,511	21,673	239	11,663	79,086	225,000	2.85	118	39	33	190	132
Las Animas	3,174,875	47,926	59,044	88,216	3,370,064	10,222,000	3.03	2,741	1,028	721	4,490	212
Mesa	120,762	31,175			151,937	498,000	3.28	153	45	51	249	197
Moffat	1,500	3,375			4,875	10,000	2.07	8	6	4	18	93
Montezuma and Ouray		4,002			4,002	19,000	4.75	12			12	209
Rio Blanco		3,349			3,349	11,000	3.28	9	2	2	13	166
Routt	383,887	11,715	36,596		432,198	1,657,000	3.83	527	230	250	1,007	51
Weld	1,389,252	56,528	28,131		1,473,911	3,738,000	2.54	860	386	242	1,488	196
Total, excluding wagon mines	9,119,545	542,783	232,255	99,879	9,994,462	31,603,000	3.16	7,911	3,158	2,437	13,506	191
Wagon mines served by rail	25,135				25,135	98,000	3.90					
Grand total	9,144,680	542,783	232,255	99,879	10,019,597	31,701,000	3.16					

[a] Includes also loaders and shot firers.
[b] Exclusive of product of wagon mines.
[c] In addition to this total 14,869 tons was produced by small mines and sold to local trade. The total production of the State was therefore 9,137,629 tons, and the total sold to local trade and used by employees was 414,685 tons.

Coal produced in Colorado, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922
Boulder	1,360,261	1,122,485	1,218,504	851,686	728,943	−122,743
Delta	89,476	90,301	120,899	89,935	105,203	+15,268
El Paso	301,647	306,039	383,977	288,531	389,403	+100,872
Fremont	871,326	823,743	871,532	590,821	478,202	−112,619
Garfield	92,655	20,539	28,376	16,795	19,778	+2,983
Gunnison	652,770	477,674	618,894	479,007	437,522	−41,485
Huerfano	2,586,911	1,858,661	2,395,261	1,755,750	2,069,350	+313,600
Jackson and Jefferson	[a] 224,408	210,388	228,821	[a] 181,027	[a] 246,639	+[a] 65,612
La Plata	138,963	111,333	127,732	99,653	79,086	−20,567
Las Animas	4,250,291	3,303,970	4,219,086	2,727,713	3,370,064	+642,351
Mesa	191,043	116,321	170,256	113,761	151,937	+38,176
Pitkin and Rio Blanco	[a]	[b] 14,748	[b] 6,472	[b] 10,992	[b] 12,226	+[b] 1,234
Routt	941,355	1,181,332	964,342	889,015	432,198	−456,817
Weld	687,609	659,660	920,073	1,028,074	1,473,911	+445,837
Small mines	[c] 18,856	26,226	4,000	[d]	25,135	[d]
	12,407,571	10,323,420	12,278,225	9,122,760	10,019,597	+896,837
Total value	$33,404,743	$28,748,534	$42,829,000	$32,377,000	$31,701,000	−$676,000

[a] Jackson and Jefferson include Pitkin and Rio Blanco in 1918; Elbert County in 1921; and Elbert and Pitkin in 1922.
[b] Moffat, Pitkin, and Rio Blanco in 1919; Moffat and Rio Blanco in 1920; Moffat, Montezuma, Ouray, Pitkin, and Rio Blanco in 1921; and Moffat, Montezuma, Ouray, and Rio Blanco in 1922.
[c] Includes Montrose and Ouray.
[d] No general canvass of wagon mines for 1921.

GEORGIA.

Commercial coal operations in Georgia are now confined to one mine. There were two in 1917 and 1918. Nevertheless, the one mine in 1922 produced 60,636 tons of coal, as against 66,716 tons from the two mines in 1918. The increase in output in 1922 over 1921, amounting to 26,821 tons, or 79.3 per cent, marked the first check to the decline in production that followed operations in 1917. The average value per ton in 1922 was the highest on record for the State except that for 1920.

Coal produced in Georgia, 1918–1922.

Year.	Net tons.					Value.		Number of employees.	Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.		
1918	21,725	888	6,250	37,853	66,716	$239,377	$3.59	190	258
1919	15,028	679	4,600	33,030	53,337	198,033	3.71	168	284
1920	15,961	791	3,600	29,804	50,156	251,000	5.00	148	294
1921	18,755	373	1,979	12,708	33,815	171,000	2.14	136	183
1922	41,809	535	2,114	16,178	60,636	246,000	4.06	150	242

ILLINOIS.

The production in Illinois in 1922 was the lowest since 1914. The total quantity mined was 58,467,736 tons, valued at $168,925,000, a decrease from 1921 of 11,135,027 tons, or 16.0 per cent, in quantity and $22,061,000, or 11.6 per cent, in value. The smaller decline in value was due to an increased average value per ton in 1922—$2.89, or 15 cents more than in 1921. Fulton, Henry, La Salle, Madison,

Marshall, Menard, and Stark counties were the only ones to show increased output in 1922. The aggregate gain for these seven counties, however, was equivalent to less than 10 per cent of the loss in Franklin County, which held first place both in production and in decrease as compared with 1921.

The declaration of the strike on April 1 brought about a complete tie-up of operations at most of the commercial mines of the State, and this suspension continued without a break throughout the period of the strike. In fact, the weekly information furnished by the producers to the Geological Survey indicated a 100 per cent paralysis, although here and there work continued at mines serving purely local needs. There was a small increase in the number of miners, loaders, shot firers, and surface workers, but a decrease in the number of miscellaneous underground workers. The decrease in the number of days worked brought down the average output per man per year, but the average output per man per day increased from 4.80 to 5.05 tons.

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Coal produced in Illinois in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Bond, Johnson, and White	344 165	12, 066	9, 433	365, 664	$872, 000	$2. 38	293	131	52	476	160
Bureau	473, 452	49, 323	33 896	556, 671	2, 101, 000	3. 78	1, 226	389	162	1, 777	126
Cass, Moultrie, Scott, and Warren	148, 938	13, 857	12 155	174, 950	468, 000	2. 67	159	42	20	221	187
Christian	2, 748, 238	146, 690	55, 982	2, 950, 910	6, 305, 000	2. 14	1, 762	892	401	3, 055	152
Clinton	690, 233	73, 646	38, 349	802, 228	2, 006, 000	2. 50	933	309	124	1, 366	98
Franklin	11, 422, 369	109, 955	415, 215	11, 947, 539	36, 842, 000	3. 08	7, 873	4, 358	1, 689	13, 920	169
Fulton	1, 313, 078	129, 875	28, 184	1, 471, 137	4, 247, 000	2. 89	2, 313	771	312	3, 396	107
Gallatin	131, 804	6, 538	7, 276	145, 618	347, 000	2. 38	220	85	59	364	85
Greene		6, 959		6, 959	25, 000	3. 59	23			23	108
Grundy	171, 189	17, 095	14, 642	202, 926	826, 000	4. 07	314	96	44	454	193
Hancock		6, 546		6, 546	33, 000	5. 04	17	2	2	21	185
Henry		24, 083	1, 946	26, 029	102, 000	3. 92	63	5	7	75	185
Jackson	998, 544	67, 034	48, 034	1, 113, 612	3, 295, 000	2. 96	944	445	173	1, 562	161
Knox		30, 752	454	31, 206	94, 000	3. 01	61	6	6	73	158
La Salle	187, 804	182, 016	14, 993	384, 813	1, 585, 000	4. 12	828	223	140	1, 191	125
Livingston	12, 805	82, 407	2, 698	97, 910	403, 000	4. 12	166	37	40	243	155
Logan, McLean, Putnam, Will, and Woodford	553, 991	143, 898	53, 617	751, 506	2, 447, 000	3. 20	1, 149	389	168	1, 706	169
McDonough		7, 534		7, 534	22, 000	2. 92	43	2	2	47	131
Macon	56, 430	154, 725	15, 579	226, 734	955, 000	4. 21	291	115	35	441	174
Macoupin	5, 927, 455	133, 781	169, 717	6, 230, 953	16, 549, 000	2. 66	4, 460	2, 546	626	7, 632	165
Madison	2, 988, 600	176, 429	113, 553	3, 278, 582	8, 606, 000	2. 62	2, 939	1, 267	417	4, 623	124
Marion	662, 675	18, 621	24, 438	705, 734	1, 894, 000	2. 68	648	301	100	1, 049	154
Marshall	157, 396	60, 405	12, 106	229, 907	1, 002, 000	4. 36	469	123	57	649	177
Menard	71, 703	44, 524	7, 114	123, 341	341, 000	2. 76	173	43	25	241	148
Mercer	155, 356	21, 470	8, 516	185, 342	625, 000	3. 37	198	76	31	305	165
Montgomery	2, 180, 590	44, 706	54, 197	2, 279, 493	6, 222, 000	2. 73	2, 220	851	298	3, 369	122
Peoria	934, 305	151, 122	16, 575	1, 102, 002	3, 035, 000	2. 75	1, 229	357	170	1, 756	164
Perry	2, 222, 319	84, 270	96, 882	2, 403, 471	6, 441, 000	2. 68	2, 199	849	319	3, 367	151
Randolph	1, 709, 154	60, 221	40, 783	1, 810, 158	4, 792, 000	2. 65	1, 173	606	151	1, 930	178
Rock Island	7, 882	57, 184	850	65, 916	209, 000	3. 17	72	22	13	107	188
St. Clair	4, 694, 093	377, 864	123, 645	5, 195, 602	11, 422, 000	2. 20	4, 945	1, 600	632	7, 177	127
Saline	4, 345, 134	63, 332	124, 009	4, 532, 475	12, 738, 000	2. 81	4, 064	1, 775	705	6, 544	138
Sangamon	5, 535, 060	288, 711	132, 984	5, 956, 755	15, 488, 000	2. 60	6, 301	2, 077	802	9, 180	153
Schuyler		7, 611		7, 611	21, 000	2. 76	21			21	151
Shelby	43, 225	28, 007	5, 088	76, 320	238, 000	3. 12	106	35	14	155	124
Stark		8, 460		8, 460	24, 000	2. 84	25	3	2	30	170
Tazewell	577, 151	105, 256	8, 952	691, 359	1, 906, 000	2. 76	674	318	90	1, 082	158
Vermilion	2, 766, 752	225, 006	48, 407	3, 040, 165	7, 728, 000	2. 54	2, 320	1, 000	599	3, 919	174

Washington	838,457	45,338	25,002	908,797	2,953,000	3.25	519	272	65	856	248
Williamson	9,103,765	104,165	291,898	9,499,828	25,777,000	2.71	7,033	2,625	1,370	11,028	160
	64,174,112	3,371,482	2,057,169	69,602,763	190,986,000	2.74	60,466	25,043	9,922	95,431	152
1922.											
Bond, Johnson, and White	263,879	13,659	6,639	284,177	829,000	2.92	375	132	41	548	103
Bureau	325,773	53,148	28,903	407,824	1,570,000	3.85	1,089	369	157	1,615	97
Cass, Hancock, Moultrie, Rock Island, and Scott	119,909	61,586	9,160	190,655	537,000	2.82	222	59	30	311	145
Christian	2,735,836	143,046	37,673	2,916,555	5,951,000	2.04	2,287	832	350	3,469	129
Clinton	581,259	44,852	32,045	658,156	1,690,000	2.57	878	331	117	1,326	85
Franklin	8,923,740	133,493	244,100	9,201,333	31,585,000	3.43	8,754	4,280	1,769	14,803	115
Fulton	1,447,575	73,414	27,785	1,548,774	4,469,000	2.74	2,024	597	439	3,060	128
Gallatin	51,496	1,321	3,314	56,131	193,000	3.43	169	78	47	294	47
Greene		3,342		3,342	11,000	3.18	12			12	174
Grundy	125,375	20,841	9,881	156,097	670,000	4.29	330	77	43	450	136
Henry		35,261	2,006	37,267	143,000	3.83	64	9	8	81	220
Jackson	655,322	51,036	38,943	745,301	2,405,000	3.23	1,109	445	179	1,733	92
Knox	1,900	23,457	555	25,912	82,000	3.18	48	5	5	58	197
La Salle	214,522	256,097	12,738	483,357	1,854,000	3.84	824	213	113	1,150	148
Livingston	2,550	27,842	500	30,892	126,000	4.10	54	21	10	85	125
Logan, McLean, Putnam, Will, and Woodford	433,655	154,419	43,640	631,714	2,317,000	3.67	1,145	357	166	1,668	146
McDonough		3,552		3,552	17,000	4.74	17	2	1	20	121
Macon	37,789	157,171	7,280	202,240	768,000	3.80	279	135	37	451	172
Macoupin	4,755,945	90,680	127,838	4,974,463	12,751,000	2.56	4,529	2,097	599	7,225	117
Madison	3,006,424	214,167	92,539	3,313,130	9,174,000	2.77	2,856	1,325	384	4,565	131
Marion	595,665	24,722	37,087	657,474	1,773,000	2.70	703	252	105	1,060	143
Marshall	162,066	62,994	10,198	235,258	974,000	4.12	544	129	52	735	165
Menard	82,940	58,374	3,983	145,297	444,000	3.06	176	44	31	251	146
Mercer	68,908	16,237	2,993	88,138	279,000	3.16	127	36	64	227	99
Montgomery	1,973,303	37,027	42,355	2,052,685	5,898,000	2.87	2,209	931	299	3,439	108
Peoria	871,907	141,653	11,327	1,024,887	2,841,000	2.77	1,192	402	181	1,775	154
Perry	1,763,124	84,839	79,461	1,927,424	5,730,000	2.97	2,284	902	430	3,616	102
Randolph	1,094,069	34,519	30,289	1,158,877	3,163,000	2.73	1,409	589	189	2,178	98
St. Clair	3,896,141	315,926	106,221	4,318,288	9,888,000	2.33	4,923	1,633	627	7,183	101
Saline	3,571,236	76,274	101,701	3,749,211	12,368,000	3.30	3,838	2,133	695	6,666	112
Sangamon	5,047,776	310,220	103,887	5,461,883	14,233,000	2.61	6,002	2,081	743	8,826	135
Schuyler		5,590		5,590	16,000	2.89	13			13	107
Shelby	31,181	19,622	4,775	55,578	196,000	3.52	95	31	14	140	113
Stark		10,580	40	10,620	37,000	3.50	21	2	3	26	200
Tazewell	526,386	97,726	7,246	631,358	1,808,000	2.86	630	220	73	923	160
Vermilion	2,654,809	227,788	37,878	2,920,475	7,795,000	2.67	2,152	872	638	3,662	159
Washington	485,958	59,307	20,289	565,554	1,785,000	3.16	546	216	73	835	154
Williamson	7,196,519	81,233	220,410	7,498,162	22,172,000	2.96	7,663	2,857	1,337	11,857	110
Total, excluding wagon mines	53,604,937	3,227,015	1,545,679	58,377,631	168,542,000	2.89	61,592	24,704	10,040	96,336	120
Wagon mines served by rail	90,105			90,105	383,000	4.25					
Grand total	53,695,042	3,227,015	1,545,679	58,467,736	168,925,000	2.89					

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Coal produced in Illinois, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Bond and White	380,869	249,326	381,586	[a] 365,664	[a] 284,177	[a] −81,487
Bureau	1,181,197	927,615	859,287	556,671	407,824	−148,847
Christian	3,340,377	2,253,181	3,392,547	2,950,910	2,916,555	−34,355
Clinton	1,533,702	1,176,836	1,311,750	802,228	658,156	−144,072
Franklin	12,373,356	9,799,321	12,837,993	11,947,539	9,201,333	−2,746,206
Fulton	2,552,105	1,522,918	2,712,598	1,471,137	1,548,774	+77,637
Gallatin	[a] 227,444	[a] 185,681	[a] 198,208	145,618	56,131	−89,487
Greene	[b] 228,237	[b] 332,416	[b] 258,994	6,959	3,342	−3,617
Grundy	317,801	191,874	245,954	202,926	156,097	−46,829
Hancock, Schuyler, Scott, and Warren	9,917	12,030	[c] 7,798	[c] 189,107	[c] 196,245	[c] −58,778
Henry	41,332	24,637	24,809	26,029	37,267	+11,238
Jackson	1,055,225	1,054,912	1,037,844	1,113,612	745,301	−368,311
Knox	7,669	10,910	24,089	31,206	25,912	−5,294
La Salle	1,083,879	749,704	874,362	384,813	483,357	+98,544
Livingston	105,341	103,647	112,449	97,910	30,892	−67,018
Logan, McLean, Putnam, Will, and Woodford	1,309,736	928,338	1,149,956	751,506	631,714	−119,792
McDonough	(b)			7,534	3,552	−3,982
Macon	347,400	(b)	290,899	226,734	202,240	−24,494
Macoupin	7,381,165	4,730,376	8,747,111	6,230,953	4,974,463	−1,256,490
Madison	5,074,383	3,217,111	4,814,927	3,278,582	3,313,130	+34,548
Marion	1,119,206	768,952	988,773	705,734	657,474	−48,260
Marshall	310,784	258,919	300,073	229,907	235,258	+5,351
Menard	203,477	138,291	205,878	123,341	145,297	+21,956
Mercer	287,443	167,517	221,226	185,342	88,138	−97,204
Montgomery	4,231,122	2,007,419	3,973,642	2,279,493	2,052,685	−226,808
Peoria	1,295,460	752,172	1,366,816	1,102,002	1,024,887	−77,115
Perry	2,917,590	2,348,124	2,802,594	2,403,471	1,927,424	−476,047
Randolph	1,627,414	1,089,998	1,595,723	1,810,158	1,158,877	−651,281
Rock Island	36,068	29,297	93,577	65,916	(c)	(c)
St. Clair	7,810,186	4,204,808	7,252,869	5,195,602	4,318,288	−877,314
Saline	5,684,594	3,952,785	5,384,912	4,532,475	3,749,211	−783,264
Sangamon	8,331,764	5,218,581	8,567,014	5,956,755	5,461,883	−494,872
Shelby	193,346	200,678	(b)	76,320	55,578	−20,742
Stark	(b)	12,714	6,185	8,460	10,620	+2,160
Tazewell	484,681	434,956	925,627	691,359	631,358	−60,001
Vermilion	3,973,478	2,573,913	3,966,506	3,040,165	2,920,475	−119,690
Washington	821,357	562,408	769,697	908,797	565,554	−343,243
Williamson	11,338,562	8,606,841	10,926,620	9,499,828	7,498,162	−2,001,666
Small mines	73,438	63,402	94,000	(d)	90,105	(d)
	89,291,105	60,862,608	88,724,893	69,602,763	58,467,736	−11,135,027
Total value	$206,860,291	$140,075,969	$273,509,000	$190,986,000	$168,925,000	−$22,061,000

[a] Johnson County included with Gallatin in 1918, 1919, and 1920; with Bond and White in 1921 and 1922
[b] Greene includes McDonough, Moultrie, and Stark counties in 1918; Macon and Moultrie in 1919; and Moultrie and Shelby in 1920; Moultrie included with Hancock, etc., in 1921.
[c] No production in Scott County in 1920; includes Cass and Moultrie in 1921; no production in Warren County, but includes Cass, Moultrie, and Rock Island counties in 1922.
[d] No canvass of wagon mines for 1921.

INDIANA.

The strike and commercial conditions reduced the average number of days worked by mines in Indiana in 1922 to 110—32 days less than the average for the bituminous mines of the country as a whole and 18 less than the average for Indiana in 1921. In this item Indiana was fourth from the bottom of the list. Nevertheless, her production in 1922 was 19,132,889 tons, valued at $54,524,000, as compared with 20,319,509 tons, valued at $52,269,000 in 1921—a decrease of only 1,186,620 tons, or 5.8 per cent, in quantity, but an increase of $2,255,000, or 4.3 per cent, in value. The average value per ton increased from $2.57 to $2.85. Greene, Parke, Perry, and Pike counties were able to increase their output in 1922, but Knox, Sullivan, Vermilion, and Vigo counties decreased. The average yearly output per worker dropped from 622 to 571 tons, but the average daily output increased from 4.86 to 5.19 tons. This daily average was the largest reported for all the States in 1922. There was a small increase in the total number of men employed.

Coal produced in Indiana in 1921 and 1922.

County	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Clay	503,721	12,227	31,532	547,480	$1,275,000	$2.33	685	317	382	1,384	84
Crawford and Dubois		8,936	208	9,144	26,000	2.84	10	3	3	16	222
Daviess	234,917	27,578	8,609	271,104	614,000	2.26	284	103	50	437	140
Fountain and Warren		2,527		2,527	8,000	3.16	11			11	145
Gibson	607,824	32,984	17,319	658,127	1,716,000	2.61	591	331	112	1,034	147
Greene	1,799,263	23,839	62,377	1,885,479	4,632,000	2.46	1,828	764	475	3,067	109
Knox	2,624,994	42,445	68,672	2,736,111	7,083,000	2.59	2,430	877	391	3,698	135
Owen	67,132	2,063	8,150	77,345	206,000	2.66	12		82	94	121
Parke	8,006	19,548	695	28,249	76,000	2.69	85	43	17	145	71
Perry		8,064		8,064	27,000	3.35	21	4	2	27	150
Pike	1,001,270	21,986	12,213	1,035,469	2,858,000	2.76	1,069	468	270	1,807	102
Spencer	4,811	2,661		7,472	18,000	2.41	18	4	6	28	111
Sullivan	3,291,929	31,984	94,522	3,418,435	8,480,000	2.48	2,973	1,560	584	5,117	135
Vanderberg	80,764	134,846	9,055	224,665	604,000	2.69	297	79	28	404	185
Vermilion	2,055,566	40,199	90,121	2,185,886	5,564,000	2.55	2,528	1,099	380	4,007	116
Vigo	6,027,304	163,339	173,602	6,364,245	16,794,000	2.64	6,552	2,514	709	9,775	140
Warrick	808,758	35,394	15,555	859,707	2,288,000	2.66	1,078	294	264	1,636	118
	19,116,259	610,620	592,630	20,319,509	52,269,000	2.57	20,472	8,460	3,755	32,687	123

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Coal produced in Indiana in 1921 and 1922—Continued.

County.	Net tons.				Value.		Number of employees.				
							Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Miners.[a]	All others.	Surface.	Total.	Average number of days worked.
1922.											
Clay	415,846	23,137	13,918	452,901	$1,243,000	$2.75	539	187	280	1,006	81
Crawford and Dubois		1,200		1,200	4,500	3.75	3	1	1	5	160
Daviess	105,208	13,217	5,369	123,794	339,000	2.74	227	73	57	357	80
Fountain and Warren		2,640		2,640	9,500	3.60	11			11	135
Gibson	479,328	18,711	15,663	513,702	1,314,000	2.56	680	296	90	1,066	95
Greene	1,876,292	29,482	40,671	1,946,445	5,228,600	2.69	1,907	777	515	3,199	107
Knox	2,420,855	43,940	42,268	2,507,063	7,235,000	2.88	2,713	952	394	4,059	102
Owen	39,221	791	815	40,827	125,000	3.07	18	1	43	62	109
Parke	92,507	20,068	3,971	116,546	341,000	2.92	158	39	24	221	156
Perry		8,500		8,500	23,000	2.70	15	3	1	19	205
Pike	1,329,380	17,105	12,843	1,359,328	3,836,000	2.82	937	423	405	1,765	124
Spencer	9,975	2,665	100	12,740	39,000	3.06	22	4	5	31	225
Sullivan	3,084,954	35,205	64,525	3,184,684	9,113,000	2.86	3,410	1,609	783	5,802	109
Vanderburg	74,514	128,063	6,101	208,678	583,000	2.79	299	90	27	416	133
Vermilion	2,038,899	44,830	63,119	2,146,848	5,910,000	2.75	2,648	1,036	380	4,064	113
Vigo	5,244,174	110,948	164,096	5,519,218	16,338,000	2.96	6,149	2,490	812	9,451	115
Warrick	749,059	36,808	19,443	805,310	2,069,000	2.57	869	307	498	1,674	109
Total, excluding wagon mines	17,960,212	537,310	452,902	18,950,424	53,750,000	2.84	20,605	8,288	4,315	33,208	110
Wagon mines served by rail	182,465			182,465	774,000	4.24					
Grand total	18,142,677	537,310	452,902	19,132,889	54,524,000	2.85					

[a] Includes also loaders and shot firers.

Coal produced in Indiana, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922
Clay	1,572,582	1,006,780	1,370,402	547,480	452,901	−94,579
Daviess	215,808	320,249	343,572	271,104	123,794	−147,310
Dubois		[a] 25,500	[a] 7,675	[a] 9,144	[a] 1,200	−[a] 7,944
Fountain and Warren	15,280	13,317	2,571	2,527	2,640	+113
Gibson	609,693	476,613	823,057	658,127	513,702	−144,425
Greene	3,426,168	2,021,868	2,878,868	1,885,479	1,946,445	+60,966
Knox	3,822,853	2,965,658	3,705,711	2,736,111	2,507,063	−229,048
Owen	[b] 266,520	97,115	121,928	77,345	40,827	−36,518
Parke	313,996	92,912	105,254	28,249	116,546	+88,297
Perry	([b])	([a])	15,997	8,064	8,500	+436
Pike	1,139,412	1,024,973	1,422,013	1,035,469	1,359,328	+323,859
Spencer	8,456	25,720	32,713	7,472	12,740	+5,268
Sullivan	4,346,857	3,096,059	4,523,306	3,418,435	3,184,684	−233,751
Vanderburg	347,440	264,760	370,993	224,665	208,678	−15,987
Vermilion	4,205,808	2,844,845	3,551,187	2,185,886	2,146,848	−39,038
Vigo	8,935,376	5,802,244	8,232,106	6,364,245	5,519,218	−845,027
Warrick	1,399,746	781,317	1,583,232	859,707	805,310	−54,397
Small mines	52,639	52,358	260,000	([c])	182,465	([c])
Total value	30,678,634	20,912,288	29,350,585	20,319,509	19,132,889	−1,186,620
	$70,384,601	$46,345,750	$92,867,000	$52,269,000	$54,524,000	+$2,255,000

[a] Dubois includes Perry County in 1919, and Crawford County in 1920, 1921, and 1922.
[b] Owen includes Perry County in 1918.
[c] No canvass of wagon mines for 1921.

IOWA.

The production of coal in Iowa in 1922 was the lowest for the State since 1896. The total output was only 4,335,161 tons, valued at $16,119,000. Compared with the output in 1921, which until 1922 was the lowest in over a quarter century, this was a decrease of 196,231 tons, or 4.3 per cent, in quantity and $1,137,800, or 6.6 per cent, in value. The average value per ton declined from $3.81 to $3.72. Monroe and Polk counties showed the heaviest losses in production; substantial increases were reported for Appanoose and some of the smaller producing counties. In Iowa, as in Illinois and Indiana, production was hard hit by the strike. The average number of days worked dropped from 148 to 131. Iowa was unlike those two States, however, in that the average daily output per worker also decreased: in 1921 it was 2.69 tons, and in 1922 it was 2.55 tons. There was an increase in the number of men employed.

Coal produced in Iowa in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
							Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Miners.[a]	All others.	Surface.	Total.	
1921.[b]											
Adams, Page, and Taylor	2,200	23,621		25,821	$102,000	$3.95	60	8	6	74	193
Appanoose	540,191	57,003	12,203	609,397	2,301,000	3.81	2,335	590	273	3,198	92
Boone	152,968	43,179	2,591	198,738	982,000	4.94	371	131	46	548	159
Dallas	299,324	6,618	3,946	309,888	1,195,000	3.86	412	188	55	655	179
Greene, Guthrie, and Warren	45,988	9,037	3,067	58,092	212,500	3.66	106	39	20	165	163
Jasper	83,846	16,555	8,009	108,410	431,000	3.98	163	113	41	317	124
Jefferson, Keokuk, and Van Buren	2,492	9,078	20	11,590	39,100	3.37	15	7	4	26	201
Lucas	223,420	2,592	10,811	236,823	887,000	3.78	269	125	45	439	211
Mahaska	36,781	9,879	1,091	47,751	171,000	3.58	74	14	10	98	139
Marion	527,561	37,159	18,468	583,188	2,140,000	3.67	699	273	96	1,068	149
Monroe	1,447,902	31,546	39,843	1,519,291	5,501,000	3.62	1,919	783	217	2,919	172
Polk	519,549	213,044	17,758	750,351	3,070,000	4.09	1,017	497	141	1,655	179
Wapello	2,000	47,799	700	50,499	135,000	2.67	66	19	10	95	175
Wayne	7,146	14,355	52	21,553	90,200	4.19	91	28	10	129	127
	3,891,368	521,465	118,559	4,531,392	17,256,800	3.81	7,597	2,815	974	11,386	148
1922.											
Adams		2,140		2,140	10,000	4.57	9			9	186
Appanoose	761,209	48,240	12,854	822,303	3,187,000	3.88	2,366	613	260	3,239	120
Boone	176,024	39,900	7,868	223,792	1,058,000	4.72	439	220	53	712	142
Dallas	299,640	11,289	1,842	312,771	1,137,000	3.64	448	198	62	708	154
Greene, Guthrie, Hardin, Lucas, Warren, and Wayne	470,297	70,352	14,245	554,894	1,739,000	3.13	936	750	96	1,782	125
Jasper	69,261	7,395	4,478	81,134	331,000	4.08	163	107	41	311	79
Jefferson, Keokuk, and Van Buren	7,052	7,300	125	14,477	44,000	3.04	18	3	2	23	226
Mahaska	20,514	8,150	624	29,288	98,000	3.36	81	14	9	104	111
Marion	483,125	36,935	13,847	533,907	1,930,000	3.62	851	303	111	1,265	135
Monroe	978,614	30,055	27,629	1,036,298	3,675,000	3.55	1,862	698	191	2,751	137
Page and Taylor	7,809	28,372	2	36,183	168,000	4.64	70	6	4	80	227
Polk	340,059	265,840	17,973	623,872	2,505,000	4.02	1,066	555	175	1,796	134
Wapello	848	23,939	415	25,202	81,000	3.23	60	10	7	77	128
Total, excluding wagon mines	3,614,452	579,907	101,902	4,296,261	15,963,000	3.72	8,369	3,477	1,011	12,857	131
Wagon mines served by rail	38,900			38,900	156,000	4.00					
Grand total	3,653,352	579,907	101,902	4,335,161	16,119,000	3.72					

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Coal produced in Iowa in 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Adams	5,418	7,418	8,419	[a]25,821	2,140	+12,502
Appanoose	1,559,253	988,225	1,511,599	609,397	822,303	+212,906
Boone	277,619	242,009	322,517	198,738	223,792	+25,054
Dallas	527,478	279,644	444,670	309,888	312,771	+2,883
Greene, Guthrie, and Warren	[b]681,119	[b]479,115	[b]328,215	58,092	[b]554,894	+[b]238,426
Jasper	248,951	138,171	(b)	108,410	81,134	−27,276
Jefferson and Keokuk	----------	8,072	1,726	[c]11,590	[c]14,477	+[c]2,887
Lucas	(b)	(b)	397,682	236,823	(b)	(b)
Mahaska	221,860	73,409	64,430	47,751	29,288	−18,463
Marion	609,266	508,767	805,723	583,188	533,907	−49,281
Monroe	2,317,929	1,734,633	2,503,276	1,519,291	1,036,298	−482,993
Page and Taylor	16,202	12,873	22,906	(a)	36,183	(a)
Polk	1,434,433	945,113	1,183,822	750,351	623,872	−126,479
Van Buren	13,195	6,667	8,845	(c)	(c)	(c)
Wapello	245,166	169,500	143,793	50,499	25,202	−25,297
Wayne	(b)	10,588	27,293	21,553	(b)	(b)
Webster	(b)	----------	----------	----------	----------	----------
Small mines	34,306	20,488	39,000	(d)	38,900	(d)
Total value	8,192,195 $24,703,237	5,624,692 $17,352,620	7,813,916 $30,794,000	4,531,392 $17,256,800	4,335,161 $16,119,000	−196,231 −$1,137,800

[a] Adams includes Page and Taylor counties in 1921.
[b] Greene, etc., includes Davis, Lucas, Wayne, and Webster counties in 1918; Lucas County in 1919; Jasper County in 1920; and Hardin, Lucas, and Wayne counties in 1922.
[c] Jefferson and Keokuk include Van Buren County in 1921 and 1922.
[d] No canvass of wagon mines for 1921.

KANSAS.

In 1922 Kansas made an output of 2,955,170 tons, valued at $10,816,000. This was the smallest production since 1896. Compared with 1921 there was a decline of 511,471 tons, or 14.8 per cent, in quantity and $2,517,300, or 18.9 per cent, in value. The average value per ton dropped from $3.85 to $3.66. With the exception of Linn County, which increased its output 16,497 tons, every county showed a decrease. Kansas was one of the 11 States to show a decrease in the total number of employees, the number reported being 7,359, as compared with 8,207 in 1921 and 9,926 in 1919. This steady decrease must be attributed, in part at least, to the persistent labor troubles and internal dissensions that have afflicted the State in the last few years. The average number of days worked was 125, or 12 less than in 1921. The average production per man per year decreased 45 tons; the average per day dropped 0.06 ton.

Coal produced in Kansas in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Cherokee	547,447	9,732	13,422	570,601	$2,047,000	$3.59	533	198	364	1,095	122
Crawford	2,579,878	53,511	79,618	2,713,007	10,515,000	3.88	4,534	1,243	799	6,576	138
Leavenworth	80,817	41,530	11,557	133,904	536,000	4.00	161	45	29	235	205
Linn	4,754	2,605	100	7,459	28,300	3.79	17	9	3	29	118
Osage	37,403	4,070	197	41,670	207,000	4.97	208	43	21	272	133
	3,250,299	111,448	104,894	3,466,641	13,333,300	3.85	5,453	1,538	1,216	8,207	137
1922.											
Cherokee	385,031	10,479	9,798	405,308	1,378,000	3.40	449	135	268	852	108
Crawford	2,115,586	35,917	50,102	2,201,605	7,937,000	3.60	4,123	995	606	5,724	116
Leavenworth and Osage	98,314	46,235	828	145,377	645,000	4.44	487	180	68	735	204
Linn	19,436	4,200	320	23,956	78,000	3.26	34	9	5	48	179
Total, excluding wagon mines	2,618,367	96,831	61,048	2,776,246	10,038,000	3.61	5,093	1,319	947	7,359	125
Wagon mines served by rail	178,924			178,924	778,000	4.35					
Grand total	2,797,291	96,831	61,048	2,955,170	10,816,000	3.66					

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Coal produced in Kansas, 1918–1922, in net tons.

	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Cherokee	1,311,230	884,732	1,090,186	570,601	405,308	−165,293
Crawford	5,984,551	4,148,172	4,508,747	2,713,007	2,201,605	−511,402
Leavenworth	134,710	89,709	143,270	133,904	[a] 145,377	[a] −30,197
Linn	8,739	10,981	[b] 13,841	7,459	23,956	+16,497
Osage	106,623	71,300	82,364	41,670	(a)	(a)
Small mines	16,094	19,830	88,000	(c)	178,924	(c)
	7,561,947	5,224,724	5,926,408	3,466,641	2,955,170	−511,471
Total value	$22,028,142	$15,917,053	$22,923,000	$13,333,300	$10,816,000	−$2,517,300

[a] Leavenworth includes Osage County. [b] Includes Bourbon County.
[c] No canvass for wagon mines for 1921.

KENTUCKY.

Kentucky established a new record for production in 1922, when the output for the State reached 42,134,175 tons, valued at $127,037,000. Compared with the preceding year this was an increase of 10,545,905 tons, or 33.4 per cent, in quantity and $41,944,400, or 49.3 per cent, in value. The average value per ton increased from $2.69 to $3.02, but this figure fell far short of the average attained in 1920—$4.11. Output in the western district increased 5,118,267 tons; in the eastern district 4,959,585 tons. For the first time in the history of the industry the State ranked second in the number of mines in operation. There was an increase of over 20 per cent in the total number of employees. The average number of days the mines worked in 1922, however, dropped to 140—2 days less than the average for the country as a whole and 12 days less than the average for the State in 1921. The eastern district worked 133 days, against an average of 160 days in 1921; and the western district 158, against 131 in 1921. Strike losses in the western district and in the Hazard and Harlan field of the eastern district were insignificant in 1922, but that part of the eastern district included in the southern Appalachian field suffered considerably during the early weeks of the general strike. Nevertheless the average output per year per man for the State increased from 625 to 684 tons and the average per day from 4.11 to 4.89 tons.

The commercial conditions that made it possible for the State to establish a new record in production are discussed on page 460.

Coal produced in Kentucky in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
								Miners.[a]	All others.			
1921.[b]												
Eastern district:												
Bell	1,648,524	22,600	24,226	.....	1,695,350	$5,068,000	$2.99	2,003	867	569	3,439	135
Boyd	39,506	2,261	963	.....	42,730	93,000	2.18	121	45	49	215	85
Breathitt	143,059	5,878	700	.....	149,637	246,000	1.64	203	81	58	342	142
Carter	65,506	2,353	322	.....	68,181	184,000	2.70	104	47	45	256	125
Clay	150,944	900	1,095	.....	152,939	319,000	2.09	145	53	36	234	159
Floyd	1,122,394	27,822	15,822	.....	1,166,038	2,922,000	2.51	1,557	696	490	2,743	116
Harlan	6,773,233	42,000	34,294	45,992	6,895,519	19,140,000	2.78	4,900	1,784	1,955	8,639	217
Johnson	697,415	13,208	30,527	.....	741,150	2,429,000	3.28	756	308	200	1,264	137
Knox	474,062	12,738	20,891	.....	507,691	1,329,000	2.62	580	261	219	1,060	163
Laurel	88,058	1,970	200	.....	90,228	218,000	2.42	251	26	29	306	188
Lee	31,083	1,760	70	.....	32,913	73,400	2.23	76	37	32	145	88
Letcher	2,424,850	37,060	38,784	.....	2,500,694	7,534,000	3.01	1,967	1,047	687	2,701	140
McCreary	603,440	7,965	441	.....	611,846	1,870,000	3.06	829	338	143	1,310	126
Martin	63,039	956	1,720	.....	65,715	120,000	1.83	64	46	47	157	132
Morgan	27,816	8,143	2,050	.....	38,009	178,000	4.68	120	66	41	227	160
Perry	4,380,147	58,727	1,185	.....	4,440,059	11,386,000	2.56	2,639	1,288	759	4,686	187
Pike	3,067,923	72,048	62,103	115,515	3,317,589	9,238,000	2.78	2,815	1,707	1,256	5,778	134
Whitley	388,583	10,479	25,077	.....	424,139	1,321,000	3.11	721	259	169	1,149	116
Other counties[c]	30,487	1,500	.....	.....	31,987	69,100	2.16	70	49	28	147	85
	22,220,069	330,368	260,470	161,507	22,972,414	63,737,500	2.77	19,981	9,005	6,812	35,798	160
Western district:												
Christian and Crittenden	116,232	1,511	7,603	.....	125,346	309,100	2.47	113	31	42	186	207
Daviess	13,160	78,093	1,768	.....	93,021	163,000	1.75	117	38	18	173	202
Hancock	2,296	2,400	.....	.....	4,696	10,000	2.13	14	2	1	17	152
Henderson	256,013	69,763	14,944	.....	340,720	911,000	2.64	337	171	63	571	156
Hopkins	1,822,115	136,269	39,225	.....	1,997,609	4,938,000	2.47	1,806	888	548	3,242	122
McLean	87,168	938	3,200	.....	91,306	195,000	2.14	143	46	22	211	71
Muhlenberg	2,996,142	133,761	94,049	.....	3,223,952	8,109,000	2.52	3,455	1,461	640	5,556	133
Ohio	804,773	22,492	35,920	.....	863,185	2,097,000	2.43	1,014	444	230	1,688	118
Union	757,965	20,249	43,086	.....	821,300	2,042,000	2.49	728	386	188	1,302	150
Webster	1,020,829	6,900	26,992	.....	1,054,721	2,581,000	2.45	1,029	524	224	1,777	125
	7,876,693	472,376	266,787	.....	8,615,856	21,355,100	2.48	8,756	3,991	1,976	14,723	131
Grand total	30,096,762	802,744	527,257	161,507	31,588,270	85,092,600	2.69	28,737	12,996	8,788	50,521	152

1922.												
Eastern district:												
Bell	1,787,768	46,500	25,145		1,859,413	5,816,000	3.13	2,646	1,177	928	4,751	100
Boyd	110,180	4,928	1,348		116,456	242,000	2.68	143	45	36	224	127
Breathitt	276,339	16,881	1,491		294,711	777,000	2.63	410	168	119	697	112
Carter	143,164	18,392	530		162,086	528,000	3.26	213	77	75	365	181
Clay	135,154	3,110	1,250		139,514	365,000	2.62	178	93	72	343	129
Floyd	2,604,062	45,473	37,327		2,686,862	7,584,000	2.82	2,332	1,093	774	4,199	142
Harlan	6,095,344	53,825	41,192	41,614	6,231,975	17,351,000	2.78	4,691	2,556	1,650	8,807	105
Johnson	321,984	8,388	14,809		345,181	1,396,000	4.05	670	233	177	1,080	71
Knott	211,935	2,242			214,177	540,000	2.52	106	41	19	166	230
Knox	436,299	5,411	8,651		450,361	1,468,000	3.26	548	319	214	1,081	125
Laurel	147,432	14,403	400		162,235	584,000	3.59	308	91	65	464	148
Lawrence	45,011	194	500		45,705	141,000	3.12	74	34	38	146	191
Lee	179,703	5,207	1,804		186,714	479,000	2.56	220	110	79	409	102
Letcher	3,577,447	39,787	41,415		3,658,649	11,977,000	3.27	2,219	1,248	790	4,257	143
McCreary	693,351	5,970	3,317		702,638	2,025,000	2.88	759	394	123	1,276	164
Martin	310,384	1,430	5,904		317,718	997,000	3.14	205	120	81	406	173
Morgan	42,541	7,417	1,573		51,531	283,000	5.50	159	46	94	299	174
Perry	4,226,217	60,728	1,076		4,288,021	12,544,000	2.93	3,034	1,350	1,071	5,455	148
Pike	5,467,091	122,398	70,038	12,045	5,671,572	16,502,000	2.91	3,454	1,977	1,359	6,790	170
Whitley	317,082	13,459	13,179		343,720	1,294,000	3.76	914	219	305	1,438	100
Other counties [d]	1,160	1,600			2,760	10,000	3.62	7			7	200
	27,129,648	477,743	270,949	53,659	27,931,999	82,903,000	2.97	23,200	11,391	8,069	42,660	133
Western district:												
Christian, Crittenden, and Hancock	56,522	4,266	3,439		64,227	231,000	3.60	186	55	46	287	88
Daviess	136,929	16,721	2,150		155,800	465,000	2.98	123	58	28	209	217
Henderson	586,167	71,599	19,314		677,080	2,286,000	3.38	514	221	84	819	200
Hopkins	3,267,514	158,257	51,017		3,476,788	9,919,000	2.85	2,706	1,060	796	4,562	136
McLean	149,480	11,844	2,995		164,319	451,000	2.74	195	63	28	286	105
Muhlenberg	4,142,230	171,048	72,355		4,385,633	14,045,000	3.20	3,751	1,589	655	5,995	156
Ohio	1,136,726	24,763	34,293		1,195,782	3,557,000	2.98	1,211	499	293	2,003	140
Union	1,327,476	39,798	49,612		1,416,886	4,416,000	3.12	936	400	181	1,517	218
Webster	2,154,048	15,106	28,454		2,197,608	6,664,000	3.03	1,367	871	348	2,586	177
	12,957,092	513,402	263,629		13,734,123	42,034,000	3.06	10,989	4,816	2,459	18,264	158
All Kentucky	40,086,740	991,145	534,578	53,659	41,666,122	124,937,000	3.00	34,189	16,207	10,528	60,924	140
Wagon mines served by rail	468,053				468,053	2,100,000	4.45					
Grand total	40,554,793	991,145	534,578	53,659	42,134,175	127,037,000	3.02					

[a] Includes also loaders and shotfirers. [b] Exclusive of product of wagon mines. [c] Knott, Lawrence, and Wayne. [d] Owsley and Wayne.

Coal produced in Kentucky, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922
Eastern district:						
Bell	2,447,875	1,972,447	2,502,546	1,695,350	1,859,413	+164,063
Boyd	110,644	62,790	119,194	42,730	116,456	+73,726
Breathitt	179,136	137,442	230,953	149,637	294,711	+145,074
Carter	187,777	151,342	162,264	68,181	162,086	+93,905
Clay	3,740	47,063	108,970	152,939	139,514	−13,425
Floyd	1,326,956	1,260,140	1,716,504	1,166,038	2,686,862	+1,520,824
Harlan	3,201,733	4,176,531	5,057,131	6,895,519	6,231,975	−663,544
Johnson	791,241	824,229	797,240	741,150	345,181	−395,969
Knox	669,437	583,128	554,769	507,691	450,361	−57,330
Laurel	129,027	74,478	137,068	90,228	162,235	+72,007
Lawrence	47,066	17,450	21,500	(a)	45,705	(a)
Lee	57,705	65,536	88,594	32,913	186,714	+153,801
Letcher	3,279,715	3,053,686	3,328,996	2,500,694	3,658,649	+1,157,955
McCreary	734,894	636,389	817,203	611,846	702,638	+90,792
Martin	(a)	(a)	(a)	65,715	317,718	+252,003
Morgan	63,332	64,831	76,042	38,009	51,531	+13,522
Perry	2,120,223	2,712,043	3,130,959	4,440,059	4,288,021	−152,038
Pike	4,473,442	4,784,899	4,925,635	3,317,589	5,671,572	+2,353,983
Whitley	842,989	632,012	693,267	424,139	343,720	−80,419
Other counties [a]	56,091	36,146	23,669	31,987	216,937	+230,655
	20,723,023	21,292,582	24,492,504	22,972,414	27,931,999	+4,959,585
Western district:						
Christian	[b] 85,259	[b] 159,463	[b] 260,914	[b] 125,346	[b] 64,227	−[b] 65,815
Daviess	86,552	68,103	94,273	93,021	155,800	+62,779
Hancock	12,280	(b)	14,130	4,696	(b)	(b)
Henderson	394,062	273,256	448,341	340,720	677,080	+336,360
Hopkins	2,987,377	2,463,010	2,755,457	1,997,609	3,476,788	+1,479,179
McLean	154,871	84,488	(b)	91,306	164,319	+73,013
Muhlenberg	3,650,473	2,626,365	3,822,695	3,223,952	4,385,633	+1,161,681
Ohio	951,829	716,312	992,036	863,185	1,195,782	+332,597
Union	992,973	892,704	1,033,371	821,300	1,416,886	+595,586
Webster	1,483,014	1,348,535	1,615,041	1,054,721	2,197,608	+1,142,887
	10,798,690	8,632,236	11,036,258	8,615,856	13,734,123	+5,118,267
Small mines	90,904	111,243	162,000	(c)	468,053	(c)
Grand total	31,612,617	30,036,061	35,690,762	31,588,270	42,134,175	+10,545,905
Total value	$80,666,842	$73,891,049	$146,576,000	$85,092,600	$127,037,000	+$41,944,400

[a] Jackson, Martin, and Pulaski in 1918; Martin, Owsley, Pulaski, and Wayne in 1919; Martin, Pulaski, and Wayne in 1920; Knott, Lawrence, and Wayne in 1921; and Knott, Owsley, and Wayne in 1922.
[b] Christian and Butler in 1918; Christian and Hancock in 1919; Christian and McLean in 1920; Christian and Crittenden in 1921; and Christian, Crittenden, and Hancock in 1922.
[c] No canvass of wagon mines for 1921.

MARYLAND.

It is necessary to go back to 1866 to find a lower record of production in Maryland than that made in 1922. Some of the choicest coal land in that State has been exhausted for several years, and the days of other valuable deposits are numbered. The sharp decreases registered in 1921 and 1922, however, are chargeable to other causes. In 1921 the general business depression was the main factor in pulling down the output of the State to 1,827,740 tons. In 1922 the strike, prolonged into a contest of endurance for months after most of the miners in other fields had returned to work, was the primary cause of the low output. At the outset of the strike, on April 1, reports from the operators showed that 80.5 per cent of the capacity of the Cumberland-Piedmont field, which includes all of Maryland and Grant, Mineral, and Tucker counties, W. Va., was affected. The last weeks of the year saw 19 to 28 per cent of the productive capacity still idle because of the strike, which had developed into a contest for continued recognition of the union.

The total output for the year, including coal from small mines for which no report was made in 1921, was 1,222,707 tons, valued at $4,122,000. Compared with 1921, this was a loss of 605,033 tons, or 33.1 per cent, in quantity and $2,480,000, or 37.6 per cent, in value. The loss was confined to Allegany County, which worked only 99 days and produced 831,641 tons less than in 1921. The Garrett County output increased 196,652 tons. The number of days worked by the State as a whole averaged 101—a decrease of 19. The average output per man per day dropped from 3.27 to 3.15 tons. The number of employees decreased from 4,668 to 3,755.

Coal produced in Maryland in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Allegany	1,426,793	47,736	22,548	1,497,077	$5,526,000	$3.69	2,265	735	552	3,552	136
Garrett	316,917	8,998	4,748	330,663	1,076,000	3.25	699	243	174	1,116	69
	1,743,710	56,734	27,296	1,827,740	6,602,000	3.61	2,964	978	726	4,668	120
1922.											
Allegany	629,064	31,983	4,389	665,436	2,448,000	3.68	1,825	450	354	2,629	99
Garrett	506,718	12,693	7,904	527,315	1,527,000	2.90	738	213	175	1,126	105
Total, excluding wagon mines	1,135,782	44,676	12,293	1,192,751	3,975,000	3.31	2,563	663	529	3,755	101
Wagon mines served by rail	29,956			29,956	147,000	4.90					
Grand total	1,165,738	44,676	12,293	1,222,707	4,122,000	3.37					

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Coal produced in Maryland, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922
Allegany	3,490,326	2,195,724	3,008,728	1,497,077	665,436	−831,641
Garrett	983,192	818,564	1,021,511	330,663	527,315	+196,652
Small mines	23,779	7,398	35,000	(a)	29,956	(a)
	4,497,297	3,021,686	4,065,239	1,827,740	1,222,707	−605,033
Total value	$12,466,189	$8,255,984	$18,815,000	$6,602,000	$4,122,000	−$2,480,000

[a] No canvass of wagon mines for 1921.

MICHIGAN.

Michigan producted 929,390 tons, valued at $4,693,000, in 1922, the lowest output reported by the State since 1900. Compared with 1921, there was a loss of 212,325 tons, or 18.6 per cent, in quantity and $862,000, or 15.5 per cent, in value. The average value per ton, however, increased from $4.87 to $5.05. Michigan is completely unionized, and that fact is emphasized in a decrease in the average number of days operated from 196 to 162, as these figures taken in connection with the fact that the strike meant a loss of 120 days show an improved demand. The average output per man per day showed an increase of 0.02 ton. There were slight decreases in the total number of employees and in the number of underground tonnage man.

Coal produced in Michigan in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Bay	330,955	2,910	14,630	348,495	$1,729,000	$4.96	445	208	86	739	193
Saginaw	690,019	6,699	49,519	746,237	3,587,000	4.81	807	343	129	1,279	210
Tuscola[c]	37,815	1,745	7,423	46,983	239,000	5.09	94	71	29	194	122
	1,058,789	11,354	71,572	1,141,715	5,555,000	4.87	1,346	622	244	2,212	196
1922.											
Bay and Calhoun	283,067	5,443	11,644	300,154	1,506,000	5.02	496	234	76	806	162
Saginaw	572,850	8,371	48,015	629,236	3,187,000	5.06	839	405	116	1,360	162
	855,917	13,814	59,659	929,390	4,693,000	5.05	1,335	639	192	2,166	162

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

[c] Includes Calhoun County.

Coal produced in Michigan, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Decrease, 1922
Bay	638,688	358,869	449,687	348,495	[a] 300,154	[a] 95,324
Saginaw	691,810	581,935	935,048	746,237	629,236	117,001
Tuscola	[b] 133,532	[b] 55,195	[b] 103,030	[b] 46,983	(a)	(a)
Small mines	788	546	2,000	(c)		(c)
Total value	1,464,818	996,545	1,489,765	1,141,715	929,390	212,325
	$5,615,097	$3,864,228	$7,346,000	$5,555,000	$4,693,000	862,000

[a] Bay includes Calhoun County and Tuscola decrease in 1922.
[b] Tuscola County includes Calhoun, Genesee, and Shiawassee in 1918; Calhoun in 1919, 1920, and 1921.
[c] No canvass of wagon mines for 1921.

MISSOURI.

In 1922 Missouri produced 2,924,750 tons of coal, or 17.7 per cent less than in 1921. The total value decreased $2,762,500, or 19.9 per cent. The average value per ton dropped from $3.92 to $3.81. Missouri, like the other unionized coal-producing fields, suffered heavily during the strike, although the suspension fell slightly short of a complete tie-up. The average number of days the mines worked declined from 166 to 113, but the average output per man per day rose from 2.50 to 2.88 tons. The total number of employees increased from 8,555 to 8,750; there was a slight decline, however, in the number of surface men.

Coal produced in Missouri in 1921 and 1922.

County.	Net tons.				Value		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Adair	509,561	8,998	9,245	527,804	$1,659,000	$3.14	663	257	114	1,034	225
Audrain	2,341	8,076	121	10,538	45,500	4.32	34	7	4	45	226
Barton	680,698	6,447	39,202	726,347	2,934,000	4.04	106	22	778	906	107
Bates	37,350	1,120	1,220	39,690	125,000	3.15	51	16	71	138	74
Boone	2,000	14,128		16,128	45,000	2.79	41	11	5	57	179
Caldwell, Clay, Dade, and Platte	65,589	23,088	2,969	91,646	372,000	4.06	158	55	20	233	177
Callaway	10,776	19,882	1,533	32,191	130,000	4.04	64	18	34	116	128
Henry	88,025	6,354	900	95,279	327,000	3.43	33	7	95	135	163
Howard, Moniteau, and Pettis	2,314	1,630	570	4,514	17,400	3.85	5	1	12	18	66
Grundy and Harrison	3,170	8,177	307	11,654	68,000	5.83	52	5	5	62	159
Johnson	12,969	1,934	337	15,240	50,000	3.28	35	26	9	70	72
Lafayette	491,450	30,153	18,818	540,421	2,316,000	4.29	1,006	480	145	1,631	162
Linn	66,198	22,948	601	89,747	428,000	4.77	177	99	13	289	157
Macon	443,659	20,180	10,146	473,985	1,784,000	3.76	931	219	69	1,219	151
Putnam	11,703	1,138	1,080	13,921	52,000	3.74	55	13	8	76	84
Randolph	306,052	12,711	6,073	324,836	1,274,000	3.92	627	192	52	871	194
Ray	420,402	49,679	6,036	476,117	2,058,000	4.32	979	372	98	1,449	189
Vernon	39,182	2,073	771	42,026	166,000	3.95	94	24	29	147	101
Other counties[c]	16,057	3,420	60	19,537	64,600	3.31	30	6	23	59	147
	3,209,496	242,136	99,989	3,551,621	13,915,500	3.92	5,141	1,830	1,584	8,555	166

1922.											
Adair	202,586	15,088	4,029	221,703	728,000	3.28	720	299	58	1,077	86
Audrain	6,065	11,347	114	17,526	73,000	4.16	29	11	3	43	252
Barton	620,292	6,343	31,457	658,092	2,441,000	3.71	106	26	711	843	89
Bates	143,334	1,153	2,560	147,047	453,000	3.08	132	30	78	240	129
Boone, Chariton, and Moniteau	1,890	11,367	300	13,557	38,000	2.80	27	6	10	43	214
Caldwell, Clay, Dade, and Platte	71,958	13,138	3,017	88,113	458,000	5.20	221	105	33	359	155
Callaway	5,115	35,368	772	41,255	170,000	4.12	111	16	37	164	159
Grundy, Harrison, and Schuyler	4,152	8,763	344	13,259	68,000	5.13	82	15	6	103	128
Henry	110,384	3,506	1,484	115,374	392,000	3.40	14	6	110	130	161
Johnson	41,549	1,792	860	44,201	170,000	3.84	60	14	33	107	113
Lafayette	371,330	27,287	17,766	416,383	1,678,000	4.03	1,011	454	122	1,587	121
Linn	32,637	20,776	394	53,807	255,000	4.74	184	85	17	286	104
Macon	330,511	16,281	5,345	352,137	1,257,000	3.57	827	177	71	1,075	105
Randolph	144,998	9,622	4,072	158,692	612,000	3.86	564	143	45	752	93
Ray	376,642	43,839	3,400	423,881	1,774,000	4.19	1,188	430	113	1,731	123
Vernon	28,440	1,881	327	30,648	106,000	3.46	66	18	15	99	92
Other counties [d]	52,773	776	108	53,657	178,000	3.22	28	13	70	111	151
Total, excluding wagon mines	2,544,656	228,327	76,349	2,849,332	10,851,000	3.81	5,370	1,848	1,532	8,750	113
Wagon mines served by rail	75,418			75,418	302,000	4.00					
Grand total	2,620,074	228,327	76,349	2,924,750	11,153,000	3.81					

[a] Include also loaders and shot firers.
[b] Exclusive of product of wagon mines.
[c] Chariton, Franklin, Ralls, and St. Clair.
[d] Franklin, Lincoln, Putnam, Ralls, and St. Clair.

Coal produced in Missouri, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Adair	755,604	517,910	777,986	527,804	221,703	−306,101
Audrain	11,747	16,683	18,626	10,538	17,526	+6,988
Barton	1,146,043	887,174	965,757	726,347	658,092	−68,255
Bates	105,078	57,050	115,621	39,690	147,047	+107,357
Boone	16,129	18,416	18,950	16,128	(a)	(a)
Caldwell, Clay, and Platte	94,090	68,119	86,617	[b] 91,646	[b] 88,113	−[b] 3,533
Callaway	48,139	51,010	58,462	32,191	41,255	+9,064
Cooper, etc. [c]	4,302	21,970	29,300	4,514	13,557	−7,085
Dade	5,327	6,324	6,342	(b)	(b)	(b)
Grundy and Harrison	[d] 79,999	31,728	23,080	11,654	[d] 13,259	+[d] 1,605
Henry	79,290	136,872	203,200	95,279	115,374	+20,095
Johnson	150,844	77,958	45,434	15,240	44,201	+28,961
Lafayette	1,009,554	651,193	885,569	540,421	416,383	−124,038
Linn	148,266	99,991	142,290	89,747	53,807	−35,940
Macon	812,677	384,846	720,227	473,985	352,137	−121,848
Putnam	45,549	37,973	30,867	13,921	(e)	(e)
Randolph	463,587	320,835	422,903	324,836	158,692	−166,144
Ray	493,980	408,148	578,694	476,117	423,881	−52,236
Vernon	(e)	47,978	74,771	42,026	30,648	−11,378
Other counties [f]	129,896	72,475	61,869	19,537	53,657	+20,199
Small mines	67,629	65,145	103,000	(g)	75,418	(g)
Total value	5,667,730 $17,126,498	3,979,798 $12,766,366	5,369,565 $22,230,000	3,551,621 $13,915,500	2,924,750 $11,153,000	−626,871 −$2,762,500

[a] Included in "Cooper, etc.," 1922.
[b] Caldwell, etc., includes Dade County in 1921 and 1922.
[c] Cooper and Moniteau in 1918; Cooper, Howard, Moniteau, and Pettis in 1919; Cooper, Howard, Moniteau, Morgan, and Pettis in 1920; Howard, Moniteau, and Pettis in 1921; and Boone, Chariton and Moniteau in 1922, no production in Cooper County in 1922.
[d] Includes Sullivan County 1918 and Schuyler County in 1922.
[e] Included in "Other counties."
[f] Other counties include Franklin, Ralls, St. Clair, and Vernon in 1918; Chariton, Franklin, Ralls, and St. Clair in 1919; Chariton, Ralls, and St. Clair in 1920; Chariton, Franklin, Ralls, and St. Clair in 1921; and Franklin, Lincoln, Putnam, Ralls, and St. Clair in 1922
[g] No canvass of wagon mines for 1921.

MONTANA.

Notwithstanding the fact that strike losses between April 1 and August 19, 1922, averaged 98 per cent of the productive capacity of the Montana mines, the total production for the year was only 5.9 per cent less than in 1921. The value of the coal mined, however, decreased 8 per cent, and the average value per ton from $3.26 to $3.19. Losses in Carbon, Cascade, and the smaller producing counties were partly offset by gains made in Musselshell County and at smaller mines in other parts of the State. There was a sharp reduction in the total number of employees, and all classes of workers shared in the loss. The average number of days the mines were in operation, however, was only 3 less than in 1921—an eloquent tribute to the toll the business depression of the earlier year exacted from the coal industry of this State. There were increases in the average output per worker per year and per day.

Coal produced in Montana in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Carbon	1,188,979	39,972	86,771	1,315,722	$4,702,000	$3.57	930	405	323	1,658	181
Cascade	634,622	31,065	20,759	686,446	1,877,000	2.73	588	212	154	954	156
Hill		9,030		9,030	28,000	3.10	10	3	3	16	186
Musselshell	641,931	7,705	12,451	662,087	2,090,000	3.16	640	313	132	1,085	111
Roosevelt	200	2,000		2,200	5,000	2.27	7			7	150
Sheridan	65	9,009	30	9,104	22,300	2.45	18	4	2	24	168
Other counties[c]	26,547	16,757	6,065	49,369	197,300	4.00	203	127	104	434	41
	2,492,344	115,538	126,076	2,733,958	8,921,600	3.26	2,396	1,064	718	4,178	143
1922.											
Blaine	2,000	11,261	173	13,434	47,000	3.50	14	6	7	27	178
Carbon	958,206	28,099	57,917	1,044,222	3,682,000	3.53	941	377	286	1,604	143
Cascade	638,233	17,791	13,889	669,913	1,912,000	2.85	537	211	128	876	144
Hill	5,024	8,714		13,738	43,000	3.15	16	2	2	20	198
Musselshell	762,122	6,313	7,342	775,777	2,343,000	3.02	627	296	106	1,029	127
Sheridan	950	8,136		9,086	19,000	2.09	16			16	172
Other counties[d]	13,725	12,099	5,396	31,220	104,500	3.35	43	12	8	63	176
Total, excluding wagon mines	2,380,260	92,413	84,717	2,557,390	8,150,500	3.19	2,194	904	537	3,635	140
Wagon mines served by rail	14,831			14,831	58,000	3.90					
Grand total	2,395,091	92,413	84,717	2,572,221	8,208,500	3.19					

[a] Includes also loaders and shot firers.
[b] Exclusive of product of wagon mines.
[c] Blaine, Carter, Chouteau, Gallatin, Judith Basin, Park, Pondera, Richland, and Toole.
[d] Chouteau, Gallatin, Pondera, Richland, Roosevelt, and Toole.

Coal produced in Montana, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Blaine	(a)	8,722	9,240	(a)	13,434	(a)
Carbon	1,647,705	1,311,130	1,814,486	1,315,722	1,044,222	−271,500
Cascade	1,272,916	724,403	983,885	686,446	669,913	−16,533
Hill	9,165	20,148	17,936	9,030	13,738	+4,708
Musselshell	1,223,091	865,907	1,140,423	662,087	775,777	+113,690
Roosevelt		4,774	3,000	2,200	(a)	(a)
Sheridan	15,812	30,643	19,623	9,104	9,086	−18
Other counties [a]	347,551	250,788	415,273	49,369	31,220	−6,915
Small mines	[b] 16,265	[b] 19,854	10,000	(c)	14,831	(c)
Total value	4,532,505 $11,444,875	3,236,369 $8,644,344	4,413,866 $13,923,000	2,733,958 $8,921,600	2,572,221 $8,208,500	−161,737 −$713,100

[a] Other counties include Blaine, Chouteau, Fergus, Phillips, Richland, and Stillwater in 1918; Carter, Chouteau, Dawson, Fergus, Gallatin, Pondera, and Richland in 1919; Carter, Chouteau, Dawson, Fergus, Golden Valley, Judith Basin, Park, Pondera, Richland, and Toole in 1920; Blaine, Carter, Chouteau, Gallatin, Judith Basin, Park, Pondera, Richland, and Toole in 1921; and Chouteau, Gallatin, Pondera, Richland, Roosevelt, and Toole in 1922.

[b] Includes Toole County.

[c] No canvass of wagon mines for 1921.

NEW MEXICO.

New Mexico was one of the 14 States producing bituminous coal to show an increase in production in 1922. The output was 3,147,173 tons, valued at $10,977,000—compared with 1921 an increase of 693,691 tons, or 28.3 per cent, in quantity and $1,392,000, or 14.5 per cent, in value. The average value per ton, however, dropped from $3.91 to $3.49. The State is largely non-union and only in McKinley County did many men respond to the strike call. The average number of days the mines worked jumped from 150 to 216—the highest reported among the important States in 1922. New Mexico shared with Virginia, which worked 198 days, the distinction of having the second highest average yearly output per worker; this average increased from 536 to 779 tons. There was a decrease of 576 in the total number of employees and an increase of 0.03 ton in the average daily output per worker. All producing counties shared in the increased production.

Coal produced in New Mexico in 1921 and 1922

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
								Miners.[a]	All others.			
1921.[b]												
Colfax	1,643,833	14,975	25,608	30,435	1,714,851	$6,077,000	$3.54	1,601	641	425	2,667	150
McKinley	477,319	9,423	27,903	----------	514,645	2,380,000	4.62	727	353	177	1,257	123
Rio Arriba	19,966	300	450	----------	20,716	65,000	3.14	25	8	7	40	245
Other counties[c]	184,916	10,056	8,298	----------	203,270	1,063,000	5.23	382	118	113	613	194
	2,326,034	[d]34,754	62,259	30,435	[d]2,453,482	9,585,000	3.91	2,735	1,120	722	4,577	150
1922.												
Colfax	1,970,175	18,610	11,394	182,339	2,182,518	$7,093,000	$3.25	1,308	561	426	2,295	208
McKinley	625,926	8,417	31,519	----------	665,862	2,493,000	3.75	578	289	218	1,085	213
Rio Arriba	27,244	262	480	----------	27,986	81,000	2.89	34	6	11	51	221
Other counties[c]	216,637	8,642	14,086	----------	239,365	1,181,000	4.93	333	113	124	570	256
Total, excluding wagon mines	2,839,982	35,931	57,479	182,339	3,115,731	10,848,000	3.48	2,253	969	779	4,001	216
Wagon mines served by rail	31,442	----------	----------	----------	31,442	129,000	4.10	----------	----------	----------	----------	----------
Grand total	2,871,424	35,931	57,479	182,339	3,147,173	10,977,000	3.49	----------	----------	----------	----------	----------

[a] Includes also loaders and shot firers.
[b] Exclusive of product of wagon mines.
[c] Lincoln, San Juan, Santa Fe, and Socorro.
[d] In addition to the amounts stated above, 3,460 tons was produced by small mines and sold to local trade. The total production was therefore 2,456,942 tons, and the total sold to local trade and used by employees was 38,214 tons.

Coal produced in New Mexico, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase, 1922.
Colfax	3,029,221	2,171,531	2,556,919	1,714,851	2,182,518	467,667
Lincoln, Santa Fe, and Socorro	207,534	219,775	274,141	[a] 203,270	[a] 239,365	[a] 36,095
McKinley	770,543	728,332	832,202	514,645	665,862	151,217
Rio Arriba	[a] 13,874	13,250	17,186	20,716	27,986	7,270
San Juan	(a)	3,949	2,992	(a)	(a)	(a)
Small mines	2,067	1,919		(b)	31,442	(b)
Total value	4,023,239 $10,787,082	3,138,756 $9,750,833	3,683,440 $13,568,000	2,453,482 $9,585,000	3,147,173 $10,977,000	693,691 $1,392,000

[a] San Juan County included with Rio Arriba in 1918 and with Lincoln in 1921 and 1922.
[b] No general canvass of wagon mines for 1921.

NORTH CAROLINA.

North Carolina has had a checkered history in the records of bituminous-coal production. Its first appearance in the list of producing States was in 1840, with a total of 3 tons. From that year until 1862 the records are silent. Between 1862 and 1873 production was resumed, reaching 30,000 tons in the first year of this period and dwindling to 10,000 tons in the last year. A seven-year hiatus followed. In 1880 the reports show an output of 350 tons, a total little bettered until 1890, when 10,262 tons was produced. From that year until 1905 production was regularly reported, then five years more of silence. Less than 400 tons was reported for 1911 and 1912. The records next begin with 1918 when an output of 1,420 tons was reported. Since that time there has been a steady increase. In 1922 the output was 78,570 tons, valued at $388,000. Compared with 1921, this was an increase of 55,132 tons, or 235.2 per cent, in quantity and $253,000, or 187.4 per cent, in value.

NORTH DAKOTA.

The production of lignite in North Dakota in 1922 amounted to 1,327,564 tons, valued at $3,513,000. This established a new record of output for the State—one of the four made in 1922. Compared with 1921, there was an increase of 462,661 tons, or 53.5 per cent, in quantity and $1,183,500, or 50.8 per cent, in value. Ward County was the only one to show a decrease, and the loss there was only 9,065 tons. The working force engaged in the industry increased from 1,064 to 1,648. Although data available indicate that over a third of the capacity of the State was closed during the period when the strike was at its height, the average number of days worked was 175, as compared with 194 the preceding year. This drop of only 19 days reflects the improved demand that flowed to the North Dakota mines during the rest of the year. North Dakota lies in the dock-distributing territory of the Northwest, but favorable freight rates on lignite, increasing costs of transportation from the docks and from Illinois and Indiana to North Dakota, and the advances that have been made in the more effective utilization of low-grade fuels have combined to create a wider home market for the product of this State. The curtailment in normal shipments of eastern coals to the docks because of the strike naturally reacted in favor of North Dakota fuel in 1922.

Lignite produced in North Dakota in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground. Miners.[a]	Underground. All others.	Surface.	Total.	
1921.[b]											
Billings	21,138	12,201		33,339	$88,000	$2.64	24	7	10	41	235
Burke	108,152	11,704	3,866	123,722	301,000	2.43	7	3	73	83	177
Burleigh	217,845	10,589	8,990	237,424	651,000	2.74	150	71	61	282	171
Divide	33,118	4,722	44	37,884	115,100	3.04	45	10	24	79	147
McLean	11,229	9,170	270	20,669	53,400	2.58	29	11	8	48	181
Mercer	120,597	1,087	8,224	129,908	359,000	2.76	81	48	39	168	265
Morton	9,400	20,451		29,851	63,000	2.11	19	5	6	30	162
Stark	33,020	6,987	2,697	42,704	117,000	2.74	27	11	16	54	219
Ward	31,696	26,907		58,603	166,000	2.83	69	9	13	91	151
Williams	26,756	25,980	256	52,992	152,000	2.87	52	14	12	78	193
Other counties[c]	87,999	5,752	4,056	97,807	264,000	2.70	63	20	27	110	218
	700,950	135,550	28,403	864,903	2,329,500	2.69	566	209	289	1,064	194
1922.											
Adams	75,224	4,930	925	81,079	218,000	2.69	54	17	27	98	203
Billings	34,797	11,347		46,144	118,000	2.56	26	8	12	46	208
Burke	206,079	25,822	7,761	239,662	605,000	2.52	10	3	132	145	189
Burleigh	245,788	13,865	6,525	266,178	761,000	2.86	179	59	55	293	164
Divide	46,925	5,733	19	52,677	139,000	2.63	37	9	9	55	212
Dunn	20,700	3,300	1,040	25,040	55,000	2.18	32	10	10	52	121
Grant	15,700	3,500		19,200	36,000	1.86	11	5	3	19	137
Hettinger	13,563	12,169	75	25,807	70,000	2.73	21	6	8	35	168
McLean	65,066	29,665	1,100	95,831	285,000	2.98	148	44	66	258	156
Mercer	124,304	360	10,635	135,299	366,000	2.71	84	65	107	256	158
Morton	25,000	24,391	2,000	51,391	98,000	1.89	37	9	20	66	228
Stark	44,875	8,913	4,355	58,143	144,000	2.48	35	12	18	65	239
Ward	22,915	26,592	31	49,538	131,000	2.64	60	16	17	93	141
Williams	50,834	36,189	116	87,139	231,000	2.65	95	21	20	136	183
Other counties[d]	26,505	4,417	3,650	34,572	76,000	2.20	17	6	8	31	224
Total, excluding wagon mines	1,018,275	211,193	38,232	1,267,700	3,333,000	2.63	846	290	512	1,648	175
Wagon mines served by rail	59,864			59,864	180,000	3.00					
Grand total	1,078,139	211,193	38,232	1,327,564	3,513,000	2.65					

[a] Includes also loaders and shot firers.
[b] Exclusive of product of wagon mines
[c] Adams, Bowman, Dunn, Hettinger, and Oliver.
[d] Bowman and Oliver.

Lignite produced in North Dakota, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Adams	(a)	39,123	(a)	(a)	81,079	(a)
Billings	(a)	31,940	47,779	33,339	46,144	+12,805
Burke	18,993	61,180	99,193	123,722	239,662	+115,940
Burleigh	b 327,478	b 323,084	254,741	237,424	266,178	+28,754
Divide	75,922	33,902	37,142	37,884	52,677	+14,793
Dunn	(a)	4,600	(a)	(a)	25,040	(a)
Grant					19,200	+19,200
Hettinger	3,840	12,785	13,433	(a)	25,807	(a)
McLean	(b)	26,437	32,302	20,669	95,831	+75,162
Mercer	(b)	(b)	107,587	129,908	135,299	+5,391
Morton	28,500	28,991	30,942	29,851	51,391	+21,540
Stark	(a)	68,429	64,114	42,704	58,143	+15,439
Ward	91,197	93,179	86,404	58,603	49,538	−9,065
Williams	50,317	66,648	73,744	52,992	87,139	+34,147
Other counties a	82,681	8,584	60,244	97,807	34,572	+68,691
Small mines	40,805	42,077	41,000	(c)	59,864	(c)
Total value	719,733 $1,629,668	840,959 $2,100,303	948,625 $2,724,000	864,903 $2,329,500	1,327,564 $3,513,000	+462,661 +$1,183,500

a Other counties include Adams, Billings, Bowman, Dunn, Oliver, and Stark counties in 1918: Bowman, Golden Valley, and Oliver in 1919; Adams, Bowman, Dunn, Golden Valley, and Oliver in 1920; Adams, Bowman, Dunn, Hettinger, and Oliver in 1921; and Bowman and Oliver in 1922.
b Burleigh County includes McLean and Mercer counties in 1918 and Mercer County in 1919.
c No canvass of wagon mines for 1921.

OHIO.

Although the production of bituminous coal in Ohio in 1922 was nearly 5,000,000 tons less than in the preceding year, increases over the output of 1921 were reported from 14 out of the 23 counties and groups of counties for which figures are shown in the following tables. The greatest individual loss and the greatest individual gain were in the eastern Ohio district, where Harrison County showed an increase of 507,835 tons and Belmont County a decrease of 4,841,333 tons. Jefferson County, in which the Pittsburgh No. 8 bed is also worked, increased its output 142,703 tons; Noble County, in the same field, suffered a loss of 201,113 tons. The second heaviest decline was in Guernsey County, in the Cambridge field. In southern Ohio, the sharp drop in Athens County wiped out the moderate gain made in Perry County; Hocking County showed little change.

The output for the State as a whole was 26,953,791 tons, valued at $87,056,000. This was the smallest production since 1915. Compared with that of 1921 it was a loss of 4,988,985 tons, or 15.6 per cent, in quantity, but an increase of $2,369,500, or 2.8 per cent, in value. Ohio, like other sections of the central competitive field, felt the full force of the general bituminous strike in 1922, but it was harder hit by adverse commercial conditions during the months preceding the strike than the other producing districts in that field. The average number of days worked by mines in the State was 100, the second lowest for the year. Illinois, on the other hand, was able to average 120 days; Indiana, 110; and Allegheny County in western Pennsylvania, 129 days. Harrison, Jefferson and Tuscarawas, were the only important producing counties in Ohio whose working time was in excess of the average for the State. One explanation for this situation is to be found in the relation of Ohio to the Lake coal trade. The eastern and southern districts of the State are active participants in that trade, which, on the bases of 1918 records (the year of maxi-

mum Lake coal tonnage to the date covered by this report), absorbs about 20 per cent of the Ohio output. Movement to the Lakes, however, does not get under real headway before April, and April marked the beginning of the strike. The normal spring and summer speeding up that would raise the total number of days worked in the year, therefore, was cut off. When production was resumed, a keen demand made possible high prices, so that the average value per ton for the year was raised to $3.23. This was an increase of 58 cents over the 1921 average but was 59 cents less than the record average of 1920. In other words, to compare average value per ton over the three years, in 1922 the operators recovered approximately 50 per cent of the decline that came in 1921.

The total number of workers in 1922 was 54,194, an increase of 2,409 over the total in 1921. All classes of workers shared in the increase, but the smallest gain—217 men—was in the unclassified underground employees. There was an increase of 991 in the number of tonnage men employed underground and of 1,201 in the number of surface workers. The average output per man per day increased from 4.60 to 4.92 tons.

Coal produced in Ohio in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				Average number of days worked
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
								Miners.[a]	All others.			
1921.[b]												
Athens	3,703,278	42,776	90,536	.....	3,836,590	$10,038,000	$2.62	5,356	1,730	873	7,959	102
Belmont	11,211,844	276,322	112,984	.....	11,601,150	29,845,000	2.57	9,318	3,093	1,480	13,891	179
Carroll	224,031	34,944	6,648	.....	265,623	717,000	2.70	342	125	60	527	159
Columbiana	529,531	59,511	15,686	.....	604,728	1,866,000	3.09	825	301	171	1,297	150
Coshocton	152,486	53,149	1,531	.....	207,166	562,000	2.71	390	133	74	597	101
Gallia, Morgan, and Washington	199,603	3,246	2,792	.....	205,641	540,700	2.63	311	103	47	461	121
Guernsey	2,817,409	59,957	104,789	.....	2,982,155	8,143,000	2.73	2,802	1,322	410	4,534	133
Harrison	1,589,938	16,758	28,734	.....	1,635,430	4,219,000	2.58	1,057	359	592	2,008	136
Hocking	815,224	43,950	10,696	.....	869,870	2,454,000	2.82	1,471	433	313	2,217	80
Holmes	.....	4,535	.....	.....	4,535	14,000	3.09	11	.....	.....	11	167
Jackson	121,831	48,054	8,718	.....	178,603	503,000	2.82	589	199	113	901	64
Jefferson	4,042,864	253,026	57,793	187	4,353,870	11,934,400	2.74	3,526	1,323	1,125	5,974	137
Lawrence	14,311	42,397	861	.....	57,569	122,000	2.12	168	45	37	250	91
Mahoning	463	35,528	132	.....	36,123	107,300	2.97	73	12	9	94	163
Medina	.....	3,174	10	.....	3,184	16,100	5.06	10	1	1	12	248
Meigs	889,204	15,430	27,401	.....	932,035	2,535,000	2.72	1,383	557	276	2,216	123
Muskingum	124,855	57,391	3,229	.....	185,475	478,000	2.58	387	105	99	591	77
Noble	513,768	6,884	18,319	.....	538,971	1,408,000	2.61	543	265	66	874	136
Perry	1,505,431	47,456	31,130	.....	1,584,017	3,928,000	2.48	2,213	689	668	3,570	89
Portage, Summit, and Wayne	61,413	22,876	13,772	.....	98,061	394,000	4.02	152	74	57	283	115
Stark	99,340	166,053	26,497	.....	291,890	985,000	3.37	484	136	102	722	151
Tuscarawas	1,065,968	266,373	28,438	.....	1,360,779	3,604,000	2.65	1,448	478	455	2,381	133
Vinton	105,601	163	3,547	.....	109,311	273,000	2.50	284	72	59	415	113
	29,788,393	1,559,953	594,243	187	31,942,776	84,686,500	2.65	33,143	11,555	7,087	51,785	134

1922.												
Athens	3,165,029	71,354	59,306		3,295,689	11,023,000	3.35	5,529	1,791	875	8,195	83
Belmont	6,410,013	271,793	78,011		6,759,817	20,756,000	3.07	8,528	2,653	1,402	12,583	100
Carroll	246,405	70,509	17,726		334,640	1,042,000	3.11	384	142	73	599	170
Columbiana	561,635	44,716	29,187		635,538	2,111,000	3.32	736	308	221	1,265	138
Coshocton	184,786	22,343	2,002		209,131	714,000	3.41	419	136	76	631	93
Gallia, Morgan, Scioto, and Washington	171,868	4,219	1,959		178,046	590,000	3.31	273	126	45	444	108
Guernsey	1,905,804	86,034	84,269		2,076,107	6,414,000	3.09	2,756	1,240	372	4,368	90
Harrison	2,073,497	13,272	56,496		2,143,265	6,527,000	3.05	1,009	458	1,025	2,492	117
Hocking	825,227	22,694	20,718		868,639	2,935,000	3.38	1,650	494	385	2,529	68
Holmes	1,895	2,793			4,688	14,000	3.01	13	1	1	15	147
Jackson	238,667	26,595	5,516		270,778	951,000	3.51	789	281	149	1,219	81
Jefferson	3,371,798	552,814	71,961		4,496,573	15,320,000	3.41	3,847	1,387	1,524	6,758	127
Lawrence	85,984	96,240	575		182,799	515,000	2.82	347	73	51	471	119
Mahoning	4,642	49,034	120		53,796	193,000	3.59	77	10	8	95	224
Medina		9,682			9,682	55,000	5.72	20	6	3	29	90
Meigs	598,605	18,591	26,656		643,852	2,402,000	3.73	1,575	588	332	2,495	68
Muskingum	288,605	64,765	2,743		356,113	1,135,000	3.19	543	120	140	803	102
Noble	319,037	5,900	12,921		337,858	1,098,000	3.25	571	316	80	967	79
Perry	1,696,320	32,569	29,587		1,758,476	5,685,000	3.23	2,615	859	796	4,270	84
Portage and Wayne	50,052	12,195	8,265		70,512	304,000	4.31	102	42	30	174	125
Stark	156,378	249,282	14,465		420,125	1,338,000	3.18	446	114	87	647	201
Summit		17,339	1,704		19,043	73,000	3.84	41	15	13	69	83
Tuscarawas	1,167,293	206,059	38,851		1,412,203	4,189,000	2.97	1,520	500	488	2,508	123
Vinton	102,407	2,430	3,040		107,877	336,000	3.11	344	112	112	568	64
Total, excluding wagon mines	24,125,947	1,953,222	566,078		26,645,247	85,720,000	3.22	34,134	11,772	8,288	54,194	100
Wagon mines served by rail	308,544				308,544	1,336,000	4.33					
Grand total	24,434,491	1,953,222	566,078		26,953,791	87,056,000	3.23					

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Coal produced in Ohio, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Athens	6,629,564	4,840,913	6,501,013	3,836,590	3,295,689	−540,901
Belmont	11,852,508	10,101,682	11,192,785	11,601,150	6,759,817	−4,841,333
Carroll	451,024	344,626	502,346	265,623	334,640	+69,017
Columbiana	673,271	634,411	857,192	604,728	635,538	+30,810
Coshocton	351,872	284,790	443,170	207,166	209,131	+1,965
Gallia	[a] 395,444	7,688	12,274	[a] 205,641	[a] 178,046	−[a] 27,595
Guernsey	4,298,812	3,334,973	3,733,810	2,982,155	2,076,107	−906,048
Harrison	2,070,414	1,427,972	2,002,585	1,635,430	2,143,265	+507,835
Hocking	2,083,928	1,575,622	2,198,998	869,870	868,639	−1,231
Holmes	3,400	8,594	9,780	4,535	4,688	+153
Jackson	836,710	492,110	834,856	178,603	270,778	+92,175
Jefferson	6,689,936	5,030,419	6,243,200	4,353,870	4,496,573	+142,703
Lawrence	273,147	141,414	301,284	57,569	182,799	+125,230
Mahoning	34,451	50,681	62,001	36,123	53,796	+17,673
Medina	7,353	4,899	6,651	3,184	9,682	+6,498
Meigs	1,299,044	897,573	1,509,837	932,035	643,852	−288,183
Morgan	(a)	[b] 212,351	[b] 286,296	(a)	(a)	(a)
Muskingum	573,836	431,235	653,056	185,475	356,113	+170,638
Noble	986,189	809,198	668,089	538,971	337,858	−201,113
Perry	3,116,432	2,519,050	3,651,343	1,584,017	1,758,476	+174,459
Portage	140,303	75,495	[c] 140,874	[c] 98,061	[c] 70,512	−[c] 8,506
Stark	533,591	387,074	449,852	291,890	420,125	+128,235
Summit	81,178	31,076	(c)	(c)	19,043	(c)
Tuscarawas	1,939,928	1,817,096	2,634,927	1,369,779	1,412,203	+51,424
Vinton	239,123	187,509	322,462	109,311	107,877	−1,434
Wayne	25,683	41,443	57,510	(c)	(c)	(c)
Small mines	225,802	186,788	602,000	(d)	308,544	(d)
	45,812,943	35,876,682	45,878,191	31,942,776	26,953,791	−4,988,985
Total value	$118,095,518	$79,496,301	$175,081,000	$84,686,500	$87,056,000	+$2,369,500

[a] Gallia County includes Morgan in 1918; Morgan and Washington in 1921; Morgan, Scioto, and Washington in 1922.
[b] Morgan includes Scioto and Washington in 1919; and Washington in 1920.
[c] Portage includes Summit in 1920; Summit and Wayne in 1921; and Wayne in 1922.
[d] No canvass of wagon mines for 1921.

OKLAHOMA.

The production of coal in Oklahoma in 1922 decreased 560,112 tons, or 16.7 per cent, as compared with 1921. The total value of the output decreased $4,019,000, or 25.9 per cent. The output for the year was 2,802,511 tons, valued at $11,527,000. In only two years in the present century has Oklahoma made a lower output—in 1901, when her production was 2,421,781 tons, and in 1910, when it was 2,646,226 tons. The nonunion county of Tulsa was the only important producing county in the State to escape a loss in tonnage. Okmulgee and Pittsburg counties—the counties of largest output—had a combined loss of 406,275 tons, or nearly 18 per cent, when compared with 1921. Part but not all of this decrease may be attributed to the general strike. The average number of days worked dropped from 141 to 114. The average yearly production per employee declined 24 tons, but the average daily production increased 0.42 ton. There was a marked decrease in all classes of labor employed, from 8,854 in 1921 to 7,828 in 1922. The number of miners, loaders, shot firers, etc., dropped 610; other underground employees, 191; surface employees, 225. In percentage the reduction in the working force in the Oklahoma mines in 1922 was one of the sharpest reported among all the States.

Coal produced in Oklahoma in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Atoka and Haskell	79,710	800	3,400	83,910	$400,000	$4.77	20	12	48	80	140
Coal	173,384	4,558	9,509	187,451	912,000	4.87	526	272	110	908	91
Craig, Muskogee, Rogers, and Wagoner	25,403	2,100		27,503	119,000	4.33	3		55	58	191
Latimer	319,401	1,871	23,387	344,659	1,611,000	4.67	573	360	164	1,097	115
Le Flore	283,276	2,774	10,764	296,814	1,326,000	4.47	404	173	101	678	165
Okmulgee	958,393	1,621	14,443	974,457	3,939,000	4.04	1,573	594	429	2,596	119
Pittsburg	1,209,240	9,431	64,880	1,283,551	6,532,000	5.09	1,750	983	398	3,131	176
Tulsa	159,574	2,404	2,300	164,278	707,000	4.30	151	31	124	306	135
	3,208,381	25,559	128,683	3,362,623	15,546,000	4.62	5,000	2,425	1,429	8,854	141
1922.											
Coal	75,351	1,949	2,547	79,847	371,000	4.63	200	96	51	347	95
Latimer	180,462	666	9,970	191,098	903,000	4.73	469	316	138	923	71
Le Flore	197,152	5,474	8,775	211,401	851,000	4.03	453	215	117	785	92
Okmulgee	823,078	1,305	5,171	829,554	3,340,000	4.03	1,505	654	306	2,465	106
Pittsburg	898,970	10,698	112,511	1,022,179	4,244,000	4.15	1,552	878	342	2,772	128
Tulsa	216,313	3,433	2,496	222,242	896,000	4.03	111	37	121	269	196
Other counties[c]	216,634	4,856	5,254	226,744	837,000	3.69	100	38	129	267	209
Total, excluding wagon mines	2,607,960	28,381	146,724	2,783,065	11,442,000	4.11	4,390	2,234	1,204	7,828	114
Wagon mines served by rail	19,446			19,446	85,000	4.35					
Grand total	2,627,406	28,381	146,724	2,802,511	11,527,000	4.11					

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

[c] Craig, Haskell, Muskogee, Rogers, and Wagoner.

Coal produced in Oklahoma, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Atoka and Haskell	246,049	129,445	96,070	83,910	(a)	(a)
Coal	542,254	427,306	461,394	187,451	79,847	−107,604
Craig		12,707	12,700	(a)	(a)	(a)
Latimer	919,487	697,177	800,442	344,659	191,098	−153,561
Le Flore	331,374	274,597	411,812	296,814	211,401	−85,413
Muskogee, Rogers, and Wagoner	[a] 121,636	48,082	35,323	[a] 27,503	[a] 226,744	+115,331
Okmulgee	1,282,139	965,497	1,477,677	974,457	829,554	−144,903
Pittsburg	1,364,207	1,170,061	1,404,170	1,283,551	1,022,179	−261,372
Tulsa	(a)	72,467	130,700	164,278	222,242	+57,964
Small mines	6,301	4,774	19,000	(b)	19,446	(b)
Total	4,813,447	3,802,113	4,849,288	3,362,623	2,802,511	−560,112
Total value	$17,508,884	$14,544,901	$23,294,000	$15,546,000	$11,527,000	−$4,019,000

[a] No production in Muskogee County in 1918; includes Tulsa County in 1918; Craig County in 1921 and Craig and Haskell counties in 1922.
[b] No canvass of wagon mines for 1921.

OREGON.

The production of coal in Oregon, which had been decreasing, on the whole before 1918, showed an upward trend in both 1919 and 1920. These gains, however, have not been held, and beginning with 1921 the coal mined in this State has been included with that of California. The Coos Bay field is the only notable producing district in the State. Fuel oil, wood, and coal from other States dominate the local markets of Oregon, which has an exceedingly low per capita consumption.

Coal produced in Oregon, 1918–1920.

Year.	Net tons.				Value.		Number of employees.	Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.		
1918	4,112	3,946	5,270	13,328	$37,454	$2.81	40	292
1919	10,917	3,103	4,719	18,739	63,794	3.40	67	259
1920	12,980	1,609	6,128	20,717	93,000	4.47	85	307

PENNSYLVANIA.

ANTHRACITE.

PRODUCTION.

Summary.—It is necessary to go back to 1902 to find a total output of anthracite in Pennsylvania comparable with that in 1922. The key to the subnormal production in both years was a general strike. That of 1922, discussed in detail on pages 452–455, tied up all deep mining in the anthracite region from April 1 to September 9—a period of 23 weeks, inclusive of holidays, other than Eight-hour Day, which has the force of a legal holiday so far as production from union mines is concerned. This was just one day less than the famous strike of

1902. As a result, the average number of days the mines were in operation dropped to 151. This was the first time the average fell below 200 days since 1906, and many of the averages in the intervening years were nearer 300 than 200 days. In 1902 the average number of days worked was 116.

The production in 1922 was only 48,824,127 gross tons, valued at $273,700,125. Compared with the preceding year, this was a decrease of 31,955,740 gross tons, or 39.6 per cent, in quantity and $178,604,778, or 39.5 per cent, in value. The loss in tonnage was entirely in freshly mined coal. The washery product was 71 per cent greater than in 1921, though considerably under the totals for 1915 to 1920. The output recovered by dredging, on the other hand, was the largest on record.

Under normal conditions there are three barriers to a marked increase in the total output of anthracite. One is the limitation involved in the physical capacity of the mines. In the early years of the anthracite industry the trade went through cycles of expansion and depression not unlike those through which the bituminous-coal industry is passing at the present time. A period of good demand and profitable returns would induce many to enter the anthracite regions to open up new mines, and established companies would increase their development. Then would follow a period in which productive capacity exceeded the demands of the consuming public. Prices and wages would be reduced, the exploitation of the anthracite areas would cease to be attractive to new capital, and development would halt for a time. With the concentration of virgin anthracite land in the hands of a relatively few interests and the change in the character of the predominating demand for this fuel, overdevelopment has passed into history. To-day existing mine capacity is nicely gaged to the demand for the larger (domestic) sizes of coal, and the surplus productive capacity that is so marked a feature in the bituminous-coal industry no longer exists.

Closely interwoven with the question of mine capacity is that of labor supply. The army of anthracite workers is smaller to-day than it was in 1914. There have, it is true, been fluctuations in the intervening years, but it is clear that at the present time there is no real reserve force upon which the anthracite industry may draw to speed up supply. How far this may be due to the fact that the physical capacity of the anthracite mines allows for no great seasonal or irregular expansions and contractions is a speculative question, the discussion of which would be out of place in a report of this character.

The third barrier is the limitation upon the producers' ability to market the smaller sizes of coal. In mining and preparing the larger sizes of anthracite a certain proportion of coal of the smaller sizes must necessarily be produced. Coal as large as chestnut once went to the culm bank, and at a still more recent date pea and the various sizes now sold as buckwheat met the same fate. Although anthracite has always held a place as a domestic fuel, in the early history of the industry as much if not more attention was given to the industrial trade. "Steamboat lump" bears witness to that fact. Anthracite displaced charcoal as a fuel for smelting iron ore, only to yield to coke made from bituminous coal. Broken coal alone of the major sizes retains a hold upon the industrial market. Even as late as the sixties anthracite producers were striving to

create a domestic market for the "smaller sizes," including chestnut. So the question of finding a market for the smaller sizes is not a new one; it is the nature of the market sought that has changed.

At present there is a strong movement on foot to effect another change in the character of the demand for a part of the output of small sizes. Chestnut was rescued from the culm bank to enter the domestic market. Pea and the buckwheats were rescued from the culm bank to enter the industrial or steam market. Improved domestic heating-plant equipment and the price differential between pea and the larger sizes have practically elevated pea from an industrial to a domestic coal. To a much smaller extent No. 1 buckwheat is also finding its way into the bins of the householder. It is toward widening this market that the force of the movement referred to is directed.

The reasons for this movement are plain. Except as the means of using these smaller sizes in domestic heating are improved and the domestic market for them is broadened, these sizes must be sold in competition with bituminous coal, not only in quotations f. o. b. mines but in quotations that include the freight rates on the coal delivered. The territory in which these sizes may be distributed for industrial consumption is therefore limited. The ability to market steam size affects indirectly the production of the domestic sizes. The cost per ton of producing both sizes is the same. The smaller sizes, however, are sold not only in direct competition with bituminous coal and other forms of industrial fuel but at prices considerably less than the average price of all anthracite produced. In order to obtain the necessary average return, therefore, the burden of the lower prices for small sizes becomes a surcharge on the prices fixed for the domestic sizes. Naturally there are limits to the amounts that may be surcharged, but the principle of this surcharge was clearly recognized by the United States Fuel Administration in its wage award that became effective November 1, 1918, by which the operators were permitted to charge the entire increase in the cost of production because of the wage award to the domestic sizes, which were advanced $1.05 a gross ton, although the engineering staff of the Fuel Administration estimated that the actual increase for all sizes was only 74 cents a ton. Subsequent increases in wage rates have widened the spread between the prices on the domestic and the steam sizes, to the advantage of competitors of anthracite in domestic markets distant from the mines.

The market for the steam sizes as such has a direct influence upon total production, because by far the greater part of the anthracite reclaimed from culm banks and river beds is sold for industrial use. The breadth of the industrial market also has a direct effect upon domestic production, because many of the smaller producers of freshly mined coal are without storage facilities. Unlike their larger competitors, they can not place steam coal in storage when the market will not absorb it but are compelled to suspend operations, even at times when the demand for their output of domestic sizes may be strong. The high records made in anthracite production in the two war years were in part attained because the shipments of sizes smaller than pea during 1917 and 1918 were respectively 3,300,000 and 4,000,000 gross tons more than in any year before or since. In 1918 shipments of reclaimed coal aggregated 22 per cent of the

total movement of steam sizes. In 1921, a year of industrial depression as compared with the boom year of 1920, the total shipments of anthracite increased 944,000 gross tons, but the shipments of steam sizes (exclusive of pea) decreased 2,531,000 gross tons.

In 1922, however, another factor entered into the market, partly upsetting the customary distribution of the steam sizes. The 23-week strike naturally operated to relieve much of the competitive pressure normally encountered in marketing the steam sizes as such—the more so as during the greater part of that period many of the eastern bituminous-coal mines were also strike-bound. Moreover, as the result of the producers' insistence upon combination orders after production was resumed, because of official orders of the emergency fuel-regulating authorities, and because of the consumers' fears, a greater relative percentage of No. 1 buckwheat found its way into the retail market than perhaps ever before. In the few months preceding the strike considerable steam coal had gone into storage, but these supplies were moved as the suspension continued. Compared with those of the preceding year the total shipments of sizes above pea decreased 20,641,476 gross tons, or 44.8 per cent; shipments of pea decreased 2,587,243 gross tons, or 44.1 per cent; shipments of sizes smaller than pea, however, decreased only 5,252,006 gross tons, or 29.8 per cent. The increase, previously noted, in the output of reclaimed coal, which consists principally of the smaller sizes, helped to pull down the percentage loss in the steam sizes.

Anthracite produced in 1890–1922.

Year.	Gross tons.	Value.	Year.	Gross tons.	Value.
1890	41,489,858	[a] $66,383,772	1915	79,459,876	$184,653,498
1895	51,785,122	[a] 82,019,272	1916	78,195,083	202,009,561
1900	51,221,253	[a] 85,757,851	1917	88,939,117	283,650,723
1905	69,339,152	[a] 141,879,000	1918	88,237,575	336,480,347
1910	75,433,246	160,275,302	1919	78,653,751	364,926,950
1911	80,771,488	175,189,392	1920	79,998,437	434,252,198
1912	75,322,855	177,622,626	1921	80,779,867	452,304,903
1913	81,718,680	195,181,127	1922	48,824,127	273,700,125
1914	81,090,631	188,181,399			

[a] Excludes value of coal used at collieries.

During the last decade there has been little change in the relative percentages of anthracite shipped from the three principal producing regions. The Wyoming region, from which 55 to 59 per cent of the total output is shipped, is still far in the lead; the Schuylkill region comes second, and the Lehigh region third. Because of the strike, all regions, including the Bernice field in Sullivan County, suffered substantial losses in output in 1922. The production in the Lehigh region declined 4,311,471 gross tons, or 39.1 per cent; in the Schuylkill region 8,128,835 gross tons, or 33.6 per cent; in the Wyoming region 19,464,534 gross tons, or 43.0 per cent. Sullivan County, with a decrease of 50,900 gross tons, showed the smallest percentage loss—17 per cent. The relatively greater loss in output in the Wyoming region in 1922 brought the percentage of the total production shipped from that region down from 57.6 in 1921 to 54.3 in 1922. This is the lowest percentage contributed to the total shipments by the Wyoming region since 1895. On the other hand, the percentage

contributed by the Schuylkill region was the highest since 1882. There was also an increase in the percentage shipped by the Lehigh region.

The quantity of coal recovered from the rivers in the anthracite regions by dredging has increased during recent years. The reports received by the Geological Survey indicate a dredge output of 152,386 gross tons in 1917, 252,616 tons in 1918, 618,833 tons in 1919, 661,119 tons in 1920, 556,544 tons in 1921, and 807,239 tons in 1922. The statistics for years prior to 1919 may not have been complete, because many of the dredge operations are small, and the operators can not

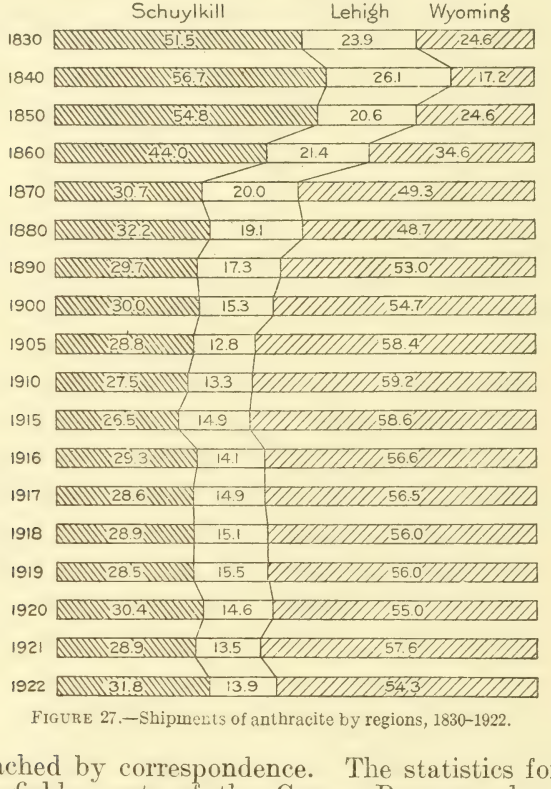


FIGURE 27.—Shipments of anthracite by regions, 1830–1922.

be easily reached by correspondence. The statistics for 1919 were collected by field agents of the Census Bureau, who presumably visited every active operation, and this change in method of obtaining reports explains in part the sharp increase in the dredge output recorded for 1919 over that for 1918. After 1919 the returns were again obtained by correspondence. The facts that during the strike of 1922 dredging operations continued without interruption at some points in the regions and that the great reduction in the output of freshly mined coal created an abnormal demand for such anthracite as was available are responsible for the heavy increase in dredge output.

Although the washery product increased from 1,716,632 to 2,943,286 gross tons, the total fell far short of that produced in 1918—7,482,576 gross tons.

The percentage of the total output used at the mines and breakers for making steam and heat has shown little change. In 1920 the quantity so used was 8,801,511 gross tons, or 11 per cent; in 1921 it was 8,714,098 tons, or 10.8 per cent; and in 1922 it was 5,626,896 tons, or 11.5 per cent. The slight increase in percentage in 1922 was no doubt due to the fact that certain operations, notably pumping, had to be continued throughout the period the mines were idle.

Anthracite produced in 1921 and 1922, by regions.

Region.	Shipped.		Sold locally.		Used for power.		Total.	
	Gross tons.	Value.[a]	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.[a]
1921.								
Lehigh:								
Freshly mined coal	9,092,702	$56,344,295	537,329	$1,905,323	1,117,214	$1,774,374	10,747,245	$60,023,992
Washery product	242,944	1,016,075	14,272	25,608	1,398	5,065	258,614	1,046,748
Dredge product	21,599	27,336			150	300	21,749	27,636
	9,357,245	57,387,706	551,601	1,930,931	1,118,762	1,779,739	11,027,608	61,098,376
Schuylkill:								
Freshly mined coal	19,382,865	119,259,110	435,606	2,659,909	3,311,935	2,100,261	23,130,406	124,019,280
Washery product	449,390	1,515,108			88,843	122,682	538,233	1,637,790
Dredge product	225,913	220,010	286,725	363,692	4,550	4,631	517,188	588,333
	20,058,168	120,994,228	722,331	3,023,601	3,405,328	2,227,574	24,185,827	126,245,403
Wyoming:								
Freshly mined coal	39,268,163	248,866,892	1,227,457	6,920,174	3,834,466	4,859,113	44,330,086	260,646,179
Washery product	616,102	2,232,474	241	506	303,442	394,783	919,785	2,627,763
Dredge product	17,199	33,115	308	1,520	100	50	17,607	34,685
	39,901,464	251,132,481	1,228,006	6,922,200	4,138,008	5,253,946	45,267,478	263,308,627
Sullivan County:								
Freshly mined coal	237,686	1,475,463	9,268	57,474	52,000	119,560	298,954	1,652,497
Total freshly mined coal	67,981,416	425,945,760	2,209,660	11,542,880	8,315,615	8,853,308	78,506,691	446,341,948
Total washery product	1,308,436	4,763,657	14,513	26,114	393,683	522,530	1,716,632	5,312,301
Total dredge product	264,711	280,461	287,033	365,212	4,800	4,981	556,544	650,654
Grand total	69,554,563	430,989,878	2,511,206	11,934,206	8,714,098	9,380,819	80,779,867	452,304,903

1922.								
Lehigh:								
Freshly mined coal	5,333,272	33,240,557	348,880	1,405,758	686,948	1,597,440	6,369,100	36,243,755
Washery product	242,433	946,321	6,457	5,249	7,019	25,602	255,909	977,172
Dredge product	91,128	106,317					91,128	106,317
	5,666,833	34,293,195	355,337	1,411,007	693,967	1,623,042	6,716,137	37,327,244
Schuylkill:								
Freshly mined coal	11,030,848	69,495,332	407,903	2,561,654	2,294,653	1,695,650	13,733,404	73,752,636
Washery product	1,546,695	5,173,923	2,823	21,847	106,061	176,546	1,655,579	5,372,316
Dredge product	429,490	505,838	232,780	271,876	5,739	7,749	668,009	785,463
	13,007,033	75,175,093	643,506	2,855,377	2,406,453	1,879,945	16,056,992	79,910,415
Wyoming:								
Freshly mined coal	21,331,904	141,301,938	1,099,040	6,430,312	2,292,100	3,868,636	24,723,044	151,600,886
Washery product	811,353	3,191,371	17,069	29,311	203,376	341,605	1,031,798	3,562,287
Dredge product	46,236	94,192	1,866	3,737			48,102	97,929
	22,189,493	144,587,501	1,117,975	6,463,360	2,495,476	4,210,241	25,802,944	155,261,102
Sullivan County:								
Freshly mined coal	210,479	1,098,749	6,575	40,615	31,060	62,000	248,054	1,201,364
Total freshly mined coal	37,906,503	245,136,576	1,862,398	10,438,339	5,304,701	7,223,726	45,073,602	262,798,641
Total washery product	2,600,481	9,311,615	26,349	56,407	316,456	543,753	2,943,286	9,911,775
Total dredge product	566,854	706,347	234,646	275,613	5,739	7,749	807,239	989,709
Grand total	41,073,838	255,154,538	2,123,393	10,770,359	5,626,896	7,775,228	48,824,127	273,700,125

[a] Value given is value at which coal left possession of producing company f. o. b. mines and does not include margins of separately incorporated selling companies.

Anthracite produced in 1916–1922.

	Shipped.		Sold locally.		Used for power.		Total.	
	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.
1916.								
Freshly mined coal	64,367,754	$189,472,889	1,833,799	$4,483,462	7,833,181	$3,631,497	74,034,734	$197,587,848
Washery product	3,104,214	3,840,147	85,444	73,955	827,381	396,780	4,017,039	4,310,882
Dredge product	29,395	23,851	59,406	61,939	54,509	25,041	143,310	110,831
	67,501,363	193,336,887	1,978,649	4,619,356	8,715,071	4,053,318	78,195,083	202,009,561
1917.								
Freshly mined coal	72,077,334	258,169,329	2,060,404	5,979,059	8,421,211	7,650,520	82,558,949	271,798,908
Washery product	5,365,517	10,953,668	13,193	20,720	849,072	670,673	6,227,782	11,645,061
Dredge product	47,192	70,804	53,512	71,128	51,682	64,822	152,386	206,754
	77,490,043	269,193,801	2,127,109	6,070,907	9,321,965	8,386,015	88,939,117	283,650,723
1918.								
Freshly mined coal	70,090,234	299,094,304	2,238,447	7,554,157	8,173,702	9,842,547	80,502,383	316,491,008
Washery product	6,506,487	18,220,906	22,759	36,747	953,330	1,365,121	7,482,576	19,622,774
Dredge product	124,436	206,971	126,686	155,352	1,494	4,242	252,616	366,565
	76,721,157	317,522,181	2,387,892	7,746,256	9,128,526	11,211,910	88,237,575	336,480,347
1919.								
Freshly mined coal	64,631,703	335,134,951	1,812,622	7,950,638	7,717,629	10,018,860	74,161,954	353,104,449
Washery product	3,016,903	9,625,998	7,238	22,312	848,823	1,305,445	3,872,964	10,953,755
Dredge product	323,689	440,733	288,016	415,596	7,128	12,417	618,833	868,746
	67,972,295	345,201,682	2,107,876	8,388,546	8,573,580	11,336,722	78,653,751	364,926,950
1920.								
Freshly mined coal	63,598,683	391,612,035	2,276,387	11,045,824	7,792,983	10,743,172	73,668,053	413,401,031
Washery product	4,615,514	17,684,475	51,476	123,969	1,002,275	2,180,427	5,669,265	19,988,871
Dredge product	396,566	544,105	258,300	309,903	6,253	8,288	661,119	862,296
	68,610,763	409,840,615	2,586,163	11,479,696	8,801,511	12,931,887	79,998,437	434,252,198

1921.								
Freshly mined coal	67,981,416	425,945,760	2,209,660	11,542,880	8,315,615	8,853,308	78,506,691	446,341,948
Washery product	1,308,436	4,763,657	14,513	26,114	393,683	522,530	1,716,632	5,312,301
Dredge product	264,711	280,461	287,033	365,212	4,800	4,981	556,544	650,654
	69,554,563	430,989,878	2,511,206	11,934,206	8,714,098	9,380,819	80,779,867	452,304,903
1922.								
Freshly mined coal	37,906,503	245,136,576	1,862,398	10,438,339	5,304,701	7,223,726	45,073,602	262,798,761
Washery product	2,600,481	9,311,615	26,349	56,407	316,456	543,753	2,943,286	9,311,745
Dredge product	566,854	706,347	234,646	275,613	5,739	7,749	807,239	989,709
	41,073,838	255,154,538	2,123,393	10,770,359	5,626,896	7,775,228	48,824,127	273,700,125

Production by counties.—In response to many requests, the Geological Survey herewith presents statistics of anthracite production, arranged by counties rather than by trade regions. Luzerne County remains by far the largest producer. Its output in 1922 was 18,710,000 gross tons, as against 12,478,000 tons for Schuylkill County, its nearest competitor, and 10,074,000 for Lackawanna County. Only two other counties, Carbon and Northumberland, produced more than 1,000,000 tons.

Including the output of dredges and the mines of Sullivan County, anthracite is shipped from 15 counties in Pennsylvania, but there are only 10 counties in which mining is carried on and 3 of these produced 85 per cent of the total supply in 1922.

Anthracite produced in 1922, by counties.

County.	Shipped.		Sold to local trade or used by employees.		Used for power.		Total.	
	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.
Berks [a]	26,000	$55,000	33,000	$78,000			59,000	$133,000
Carbon [b]	1,468,000	8,329,000	50,000	174,000	171,000	$417,000	1,689,000	8,920,000
Columbia [b]	337,000	1,766,000	19,000	45,000	39,000	95,000	395,000	1,906,000
Cumberland [a] and Susquehanna [b]	11,000	83,000	7,000	5,000			18,000	88,000
Dauphin [b]	656,000	2,816,000	140,000	275,000	156,000	272,000	952,000	3,363,000
Lackawanna [b]	8,780,000	56,703,000	384,000	2,427,000	910,000	1,553,000	10,074,000	60,683,000
Luzerne [b]	15,786,000	102,887,000	1,036,000	5,169,000	1,888,000	3,283,000	18,710,000	111,339,000
Montour [a]	2,000	4,000	1,000	1,000			3,000	5,000
Northampton [a]	61,000	65,000					61,000	65,000
Northumberland [b]	3,007,000	18,172,000	149,000	849,000	651,000	562,000	3,807,000	19,583,000
Schuylkill [b]	10,416,000	61,270,000	292,000	1,680,000	1,770,000	1,511,000	12,478,000	64,461,000
Sullivan [b]	210,000	1,099,000	7,000	40,000	31,000	62,000	248,000	1,201,000
Wayne [b]	276,000	1,865,000	5,000	27,000	11,000	20,000	292,000	1,912,000
York [a]	38,000	41,000					38,000	41,000
	41,074,000	255,155,000	2,123,000	10,770,000	5,627,000	7,775,000	48,824,000	273,700,000

[a] Counties producing dredge coal only in 1922.

[b] Counties producing freshly mined coal.

SHIPMENTS.

Anthracite shipped from the Schuylkill, Lehigh, and Wyoming regions in 1807 and from 1820 to 1922.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total (gross tons).
	Gross tons.	Percentage.	Gross tons.	Percentage.	Gross tons.	Percentage.	
1807					55		55
1820			365				365
1821			1,073				1,073
1822	1,480	39.8	2,240	60.2			3,720
1823	1,128	16.2	5,823	83.8			6,951
1824	1,567	14.1	9,541	85.9			11,108
1825	6,500	18.6	28,393	81.4			34,893
1826	16,767	34.9	31,280	65.1			48,047
1827	31,360	49.4	32,074	50.6			63,434
1828	47,284	61.0	30,232	39.0			77,516
1829	79,973	71.4	25,110	22.4	7,000	6.2	112,083
1830	89,984	51.5	41,750	23.9	43,000	24.6	174,734
1831	81,854	46.3	40,966	23.2	54,000	30.5	176,820
1832	209,271	57.6	70,000	19.3	84,000	23.1	363,271
1833	252,971	51.9	123,001	25.2	111,777	22.9	487,749
1834	226,692	60.2	106,244	28.2	43,700	11.6	376,636
1835	339,508	60.5	131,250	23.4	90,000	16.1	560,758
1836	432,045	63.1	148,211	21.7	103,861	15.2	684,117
1837	530,152	61.0	223,902	25.7	115,387	13.3	869,441
1838	446,875	60.5	213,615	28.9	78,207	10.6	738,697
1839	475,077	58.1	221,025	27.0	122,300	14.9	818,402
1840	490,596	56.7	225,313	26.1	148,470	17.2	864,379
1841	624,466	65.1	143,037	14.9	192,270	20.0	959,773
1842	583,273	52.6	272,540	24.6	252,599	22.8	1,108,412
1843	710,200	56.2	267,793	21.2	285,605	22.6	1,263,598
1844	887,937	54.5	377,002	23.1	365,911	22.4	1,630,850
1845	1,131,724	56.2	429,453	21.3	451,836	22.5	2,013,013
1846	1,308,500	55.8	517,116	22.1	518,389	22.1	2,344,005
1847	1,665,735	57.8	633,507	22.0	583,067	20.2	2,882,309
1848	1,733,721	56.1	670,321	21.7	685,196	22.2	3,089,238
1849	1,728,500	53.3	781,556	24.1	732,910	22.6	3,242,966
1850	1,840,620	54.8	690,456	20.6	827,823	24.6	3,358,899
1851	2,328,525	52.3	964,224	21.7	1,156,167	26.0	4,448,916
1852	2,636,835	52.8	1,072,136	21.5	1,284,500	25.7	4,993,471
1853	2,665,110	51.3	1,054,309	20.3	1,475,732	28.4	5,195,151
1854	3,191,670	53.2	1,207,186	20.1	1,603,478	26.7	6,002,334
1855	3,552,943	53.8	1,284,113	19.4	1,771,511	26.8	6,608,567
1856	3,603,029	52.0	1,351,970	19.5	1,972,581	28.5	6,927,580
1857	3,373,797	50.8	1,318,541	19.8	1,952,603	29.4	6,644,941
1858	3,273,245	47.9	1,380,030	20.2	2,186,094	31.9	6,839,369
1859	3,448,708	44.1	1,628,311	20.9	2,731,236	35.0	7,808,255
1860	3,749,632	44.0	1,821,674	21.4	2,941,817	34.6	8,513,123
1861	3,160,747	39.7	1,738,377	21.9	3,055,140	38.4	7,954,264
1862	3,372,583	42.8	1,351,054	17.2	3,145,770	40.0	7,869,407
1863	3,911,683	40.9	1,894,713	19.8	3,759,610	39.3	9,566,006
1864	4,161,970	40.9	2,054,669	20.2	3,960,836	38.9	10,177,475
1865	4,356,959	45.2	2,040,913	21.1	3,254,519	33.7	9,652,391
1866	5,787,902	45.6	2,179,364	17.1	4,736,616	37.3	12,703,882
1867	5,161,671	39.7	2,502,054	19.3	5,325,000	41.0	12,988,725
1868	5,330,737	38.6	2,502,582	18.1	5,968,146	43.3	13,801,465
1869	5,775,138	41.7	1,949,673	14.0	6,141,369	44.3	13,866,180
1870	4,968,157	30.7	3,239,374	20.0	7,974,660	49.3	16,182,191
1871	6,552,772	41.8	2,235,707	14.2	6,911,242	44.0	15,699,721
1872	6,694,890	34.1	3,873,339	19.7	9,101,549	46.2	19,669,778
1873	7,212,601	34.0	3,705,596	17.4	10,309,755	48.6	21,227,952
1874	6,866,877	34.1	3,773,836	18.7	9,504,408	47.2	20,145,121
1875	6,281,712	31.9	2,834,605	14.4	10,596,155	53.7	19,712,472
1876	6,221,934	33.6	3,854,919	20.9	8,424,158	45.5	18,501,011
1877	8,195,042	39.3	4,332,760	20.8	8,300,377	39.9	20,828,179
1878	6,282,226	35.7	3,237,449	18.4	8,085,587	45.9	17,605,262
1879	8,960,829	34.3	4,595,567	17.6	12,586,293	48.1	26,142,689
1880	7,554,742	32.3	4,463,221	19.0	11,419,279	48.7	23,437,242

Anthracite shipped from the Schuylkill, Lehigh, and Wyoming regions in 1807 and from 1820 to 1922—Continued.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total (gross tons).
	Gross tons.	Percentage.	Gross tons.	Percentage.	Gross tons.	Percentage.	
1881	9,253,958	32.4	5,294,676	18.6	13,951,383	49.0	28,500,017
1882	9,459,288	32.5	5,689,437	19.5	13,971,371	48.0	29,120,096
1883	10,074,726	31.7	6,113,809	19.2	15,604,492	49.1	31,793,027
1884	9,478,314	30.9	5,562,226	18.1	15,677,753	51.0	30,718,293
1885	9,488,426	30.0	5,898,634	18.7	16,236,470	51.3	31,623,530
1886	9,381,407	29.2	5,723,129	17.8	17,031,826	53.0	32,136,362
1887	10,609,028	30.6	4,347,061	12.6	19,684,929	56.8	34,641,018
1888	10,654,116	27.9	5,639,236	14.8	21,852,366	57.3	38,145,718
1889	10,486,185	29.3	6,294,073	17.6	19,036,835	53.1	35,817,093
1890	10,867,822	29.7	6,329,658	17.3	19,417,979	53.0	36,615,459
1891	12,741,258	31.5	6,381,838	15.8	21,325,240	52.7	40,448,336
1892	12,626,784	30.1	6,451,076	15.4	22,815,480	54.5	41,893,340
1893	12,357,444	28.7	6,892,352	16.0	23,839,741	55.3	43,089,537
1894	12,035,005	29.1	6,705,434	16.2	22,650,761	54.7	41,391,200
1895	14,269,932	30.7	7,298,124	15.7	24,943,421	53.6	46,511,477
1896	13,097,571	30.4	6,490,441	15.0	23,589,473	54.6	43,177,485
1897	12,181,061	29.3	6,249,540	15.0	23,207,263	55.7	41,637,864
1898	12,078,875	28.8	6,253,109	14.9	23,567,767	56.3	41,899,751
1899	14,199,009	29.8	6,887,909	14.4	26,578,286	55.8	47,665,204
1900	13,502,732	30.0	6,918,627	15.3	24,686,125	54.7	45,107,484
1901	16,019,591	29.9	7,211,974	13.5	30,337,036	56.6	53,568,601
1902	8,471,391	27.2	3,470,736	11.1	19,258,763	61,7	31,200,890
1903	16,474,790	27.7	7,164,783	12.1	35,723,258	60.2	59,362,831
1904	16,379,293	28.5	7,107,220	12.4	34,006,009	59.1	57,492,522
1905	17,703,099	28.8	7,849,205	12.8	35,857,897	58.4	61,410,201
1906	16,011,285	28.8	7,046,617	12.6	32,640,693	58.6	55,698,595
1907	20,141,288	30.0	8,329,653	12.4	38,638,452	57.6	67,109,393
1908	18,006,464	27.9	7,786,255	12.0	38,872,295	60.1	64,665,014
1909	16,864,147	27.2	7,532,271	12.2	37,573,467	60.6	61,969,885
1910	17,845,020	27.5	8,627,539	13.3	38,433,227	59.2	64,905,786
1911	19,118,300	27.4	9,682,147	13.9	41,033,354	58.7	69,833,801
1912	18,213,960	28.2	8,800,125	13.6	37,653,164	58.2	64,667,249
1913	19,417,385	27.4	10,180,021	14.4	41,160,906	58.2	70,758,312
1914 [a]	18,416,586	26.3	10,272,308	14.7	41,258,463	59.0	69,947,357
1915 [a]	18,043,709	26.5	10,190,421	14.9	39,945,344	58.6	68,179,474
1916 [a]	19,677,476	29.3	9,437,545	14.1	37,945,335	56.6	67,060,356
1917 [a]	22,028,055	28.6	11,456,963	14.9	43,577,769	56.5	77,062,787
1918 [a]	22,009,607	28.9	11,552,042	15.1	42,746,038	56.0	76,307,687
1919 [a]	19,248,280	28.5	10,452,093	15.5	37,899,347	56.0	67,599,720
1920 [a]	20,733,428	30.4	9,939,241	14.6	37,517,036	55.0	68,189,705
1921 [a]	20,058,168	28.9	9,357,245	13.5	39,901,464	57.6	69,316,877
1922 [a]	13,007,033	31.8	5,666,833	13.9	22,189,493	54.3	40,863,359
	787,341,722	30.8	390,470,081	15.2	1,381,371,322	54.0	2,559,183,125

[a] 1914–1922 inclusive of dredge shipments.

Accuracy of the statistics of washery coal.—The figures of washery production given in this report probably fall short of the total quantity recovered from culm banks. The producing company is asked to report not its total output of fresh mined and washery coal but rather the output of each individual breaker or culm-bank washery. When, as sometimes happens, coal from a washery is in turn passed through a breaker for further sizing or cleaning, it is not always possible for the operator to state just how much of the finished product is culm-bank and how much is fresh-mined coal, though the Geological Survey seeks to obtain from him a separation of the two. Again, coal from a culm bank passed directly to a breaker for preparation may not be

reported as "washery" coal but as "breaker" coal. It is probable, therefore, that the statistics published by the Geological Survey slightly overstate the quantity of fresh-mined coal. They represent rather the total products of the breakers minus some but not all of the culm-bank coal. Conversely, the statistics of washery coal indicate the total quantity produced by washeries more nearly than the total quantity recovered from culm banks.

In the forthcoming report for 1923 a more accurate measurement of the quantity derived from culm banks will be attempted.

The percentage of sizes in the output of the breakers shows little change from year to year. Although the relation that the output of each size bears to the total output (including that of the washeries and dredges) is not absolutely constant, the change in no year has exceeded 2 per cent, except that for stove in 1921 and those for chestnut and barley in 1922. The percentage of freshly mined coal of sizes above pea, which showed a gradual increase from 1915 to 1921, declined slightly in 1922. The difference from year to year in the output of the washeries and dredges results in a greater fluctuation in the percentage of the total shipments of all coal smaller than pea. This percentage was lower in 1921 than in any other year since 1913, but for the reasons heretofore explained, it was larger in 1922 than in any other year since 1918.

Anthracite shipped, 1913–1922, by sizes.[a]

	Sizes above pea.		Pea.		Sizes below pea.		Total (gross tons).
	Gross tons.	Percentage of total.	Gross tons.	Percentage of total.	Gross tons.	Percentage of total.	
1913: Freshly mined coal	43,781,936	63.3	8,056,919	11.6	17,366,691	25.1	69,205,546
Total shipments	43,935,224	61.6	8,209,479	11.5	19,198,469	26.9	71,343,172
1914: Freshly mined coal	43,112,545	62.8	8,142,829	11.8	17,472,101	25.4	68,727,475
Total shipments	43,176,836	61.3	8,277,619	11.7	19,009,591	27.0	70,464,046
1915: Freshly mined coal	41,125,513	62.2	8,011,934	12.1	17,036,370	25.7	66,173,817
Total shipments	41,213,703	60.0	8,210,668	12.0	19,242,085	28.0	68,666,456
1916: Freshly mined coal	40,575,269	63.1	7,223,529	11.2	16,568,956	25.7	64,367,754
Total shipments	40,747,215	60.4	7,520,804	11.1	19,233,344	28.5	67,501,363
1917: Freshly mined coal	46,640,319	64.7	6,298,870	8.7	19,138,145	26.6	72,077,334
Total shipments	47,195,895	60.9	6,824,003	8.8	23,470,145	30.3	77,490,043
1918: Freshly mined coal	45,323,253	64.7	5,798,401	8.3	18,968,580	27.0	70,090,234
Total shipments	45,994,903	60.0	6,471,381	8.4	24,254,873	31.6	76,721,157
1919: Freshly mined coal	42,937,454	66.4	5,884,492	9.1	15,809,757	24.5	64,631,703
Total shipments	43,349,551	63.8	6,237,398	9.2	18,385,346	27.0	67,972,295
1920: Freshly mined coal	42,209,170	66.4	5,008,050	7.9	16,381,463	25.7	63,598,683
Total shipments	42,984,656	62.6	5,457,588	8.0	20,168,519	29.4	68,610,763
1921: Freshly mined coal	45,796,115	67.4	5,720,904	8.4	16,464,397	24.2	67,981,416
Total shipments	46,051,199	66.2	5,865,379	8.4	17,637,985	25.4	69,554,563
1922: Freshly mined coal	25,046,679	66.1	2,967,355	7.8	9,892,469	26.1	37,906,503
Total shipments	25,409,723	61.8	3,278,136	8.0	12,385,979	30.2	41,073,838

[a] Includes shipments of dredge coal.

By excluding dredge coal, the record for which begins in 1909, and by excluding the product of the Bernice Basin, in Sullivan County, it is possible to present figures showing the relative proportions of steam and domestic sizes in the shipments for a much longer period than that given in the preceding table.

Shipments of the domestic sizes other than pea have declined from 76.9 per cent of the total in 1890 to a figure between 60 and 66 per cent in recent years. Details are given in the following table:

Anthracite shipped from mines and washeries, by sizes, 1890–1922.[a]

Year.	Domestic.		Pea and steam.		Total (gross tons).
	Gross tons.	Percentage of total.	Gross tons.	Percentage of total.	
1890	28,154,000	76.9	8,461,000	23.1	36,615,000
1891	30,604,000	75.7	9,844,000	24.3	40,448,000
1892	31,868,000	76.0	10,025,000	24.0	41,893,000
1893	32,294,000	74.9	10,796,000	25.1	43,090,000
1894	30,482,000	73.7	10,909,000	26.3	41,391,000
1895	32,469,000	69.9	14,042,000	30.1	46,511,000
1896	30,355,000	70.3	12,822,000	29.7	43,177,000
1897	28,510,000	68.5	13,128,000	31.5	41,638,000
1898	28,199,000	67.3	13,701,000	32.7	41,900,000
1899	31,507,000	66.1	16,158,000	33.9	47,665,000
1900	29,162,000	64.7	15,945,000	35.3	45,107,000
1901	34,413,000	64.2	19,156,000	35.8	53,569,000
1902	19,026,000	61.0	12,175,000	39.0	31,201,000
1903	37,739,000	63.6	21,624,000	36.4	59,363,000
1904	35,637,000	62.0	21,856,000	38.0	57,493,000
1905	37,425,000	60.9	23,985,000	39.1	61,410,000
1906	32,894,000	59.1	22,805,000	40.9	55,699,000
1907	39,333,000	58.6	27,776,000	41.4	67,109,000
1908	38,319,000	59.3	26,346,000	40.7	64,665,000
1909	36,205,000	58.3	25,948,000	41.7	62,153,000
1910	38,186,000	58.6	27,008,000	41.4	65,194,000
1911	41,476,000	59.4	28,358,000	40.6	69,834,000
1912	39,298,000	60.8	25,369,000	39.2	64,667,000

Year.	Domestic.		Pea.		Steam.		Total (gross tons).
	Gross tons.	Percentage of total.	Gross tons.	Percentage of total.	Gross tons.	Percentage of total.	
1913	43,689,000	61.7	8,143,000	11.5	18,927,000	26.8	70,759,000
1914	42,952,000	61.4	8,208,000	11.7	18,770,000	26.9	69,930,000
1915	40,993,000	60.1	8,152,000	12.0	19,017,000	27.9	68,162,000
1916	40,556,000	60.5	7,468,000	11.1	19,006,000	28.4	67,030,000
1917	47,003,000	61.0	6,774,000	8.8	23,239,000	30.2	77,016,000
1918	45,795,000	60.1	6,417,000	8.4	23,972,000	31.5	76,184,000
1919	43,166,000	64.2	6,185,000	9.2	17,925,000	26.6	67,276,000
1920	42,784,000	63.1	5,402,000	8.0	19,607,000	28.9	67,793,000
1921	45,906,000	66.5	5,828,000	8.4	17,318,000	25.1	69,052,000
1922	25,334,000	62.9	3,256,000	8.1	11,707,000	29.0	40,297,000

[a] Exclusive of Sullivan County and dredge coal.

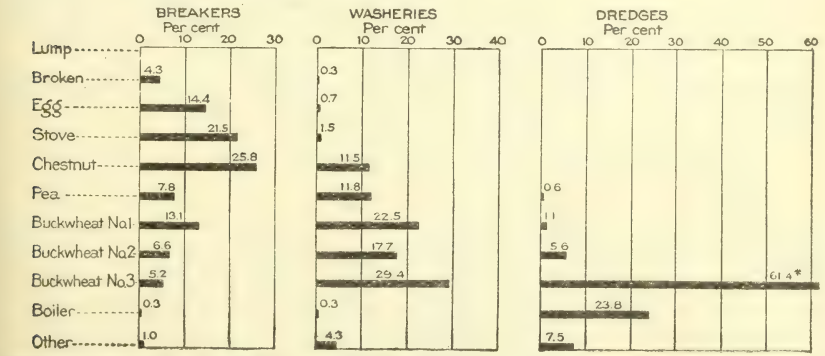


FIGURE 28.—Percentage of each size in shipments of anthracite from breakers, washeries, and dredges, 1922.

* Includes a large quantity reported as "river coal."

The decline in the percentage of domestic sizes in the total shipments reflects, of course, the increase in shipments of washery and dredge coal, in which the steam sizes greatly predominate. The following table shows for the period between 1890 and 1922 the relative proportions of the total shipments contributed by breakers, washeries, and dredges. The output of the washeries, which was small in 1890, reached a maximum in 1907 and afterward declined. In response to the immense demand for steam coal during the war, however, it rose to 6,506,000 gross tons in 1918, the highest figure ever recorded and one that is not likely to be attained again. The statistics in the following table include, where possible, the output of Sullivan County.

Anthracite shipped from mines, washeries, and dredges, 1890–1922, in gross tons.[a]

Year.	Mines.	Washeries.	Dredges.	Total.
1890	36,573,000	42,000		36,615,000
1891	40,362,000	86,000		40,448,000
1892	41,803,000	90,000		41,893,000
1893	42,845,000	245,000		43,090,000
1894	40,757,000	634,000		41,391,000
1895	45,430,000	1,081,000		46,511,000
1896	42,282,000	895,000		43,177,000
1897	40,802,000	994,000		41,796,000
1898	40,944,000	1,099,000		42,043,000
1899	46,455,000	1,368,000		47,823,000
1900	43,218,000	2,059,000		45,277,000
1901	51,128,000	2,567,000		53,695,000
1902	29,527,000	1,959,000		31,486,000
1903	56,046,000	3,563,000		59,609,000
1904	54,927,000	2,800,000		57,727,000
1905	59,010,000	2,644,000		61,654,000
1906	52,139,000	3,847,000		55,986,000
1907	63,158,000	4,301,000		67,459,000
1908	61,473,000	3,646,000		65,119,000
1909	58,994,000	3,685,000	9,000	62,688,000
1910	62,417,000	3,296,000	22,000	65,735,000
1911	67,253,000	3,172,000	17,000	70,442,000
1912	62,046,000	3,155,000	28,000	65,229,000
1913	69,206,000	2,090,000	47,000	71,343,000
1914	68,727,000	1,720,000	17,000	70,464,000
1915	66,174,000	2,475,000	17,000	68,666,000
1916	64,368,000	3,104,000	29,000	67,501,000
1917	72,077,000	5,366,000	47,000	77,490,000
1918	70,090,000	6,506,000	125,000	76,721,000
1919	64,632,000	3,017,000	323,000	67,972,000
1920	63,599,000	4,616,000	396,000	68,611,000
1921	67,981,000	1,308,000	265,000	69,554,000
1922	37,906,503	2,600,481	566,854	41,073,838

[a] Includes shipments from Sullivan County, except for 1891 to 1896, for which data are not available.

Shipments by months, 1917–1922, as reported by the Anthracite Bureau of Information, are given in the following table:

Anthracite shipped in 1917–1922, by months, in gross tons.[a]

Month.	1917	1918	1919	1920	1921	1922
January	5,940,725	5,638,383	5,934,241	5,713,319	5,740,538	4,848,053
February	5,178,432	5,812,082	3,871,932	4,913,664	5,966,101	5,239,614
March	6,989,075	7,276,777	3,938,908	6,077,821	5,737,771	6,778,667
April	5,592,299	6,368,373	5,224,715	4,814,211	5,967,465	[b]
May	6,917,525	6,887,256	5,711,915	6,155,878	5,793,895	[b]
June	7,049,037	6,867,669	5,619,591	6,319,957	6,031,937	[b]
July	6,724,252	7,084,775	6,052,334	6,389,100	5,462,760	[b]
August	7,013,996	7,180,923	6,144,144	6,207,653	5,575,115	[b]
September	6,372,756	6,234,395	5,687,401	3,592,954	5,519,412	3,746,433
October	7,110,950	6,286,366	6,560,150	6,240,901	5,872,783	6,567,928
November	6,545,313	5,276,659	5,971,671	5,765,347	5,314,014	6,420,102
December	5,698,945	5,736,260	6,138,460	6,436,320	4,635,922	6,454,876
	77,133,305	76,649,918	66,855,462	68,627,125	67,617,713	40,055,073

[a] Does not include shipments from Sullivan County nor from dredges. [b] Strike.

NUMBER OF OPERATIONS.

In contrast to the thousands of mines that produce bituminous coal, the number of mines in the anthracite regions is small. In 1920 the Geological Survey received reports from 174 producers of anthracite, who operated during the year a total of 252 breakers,

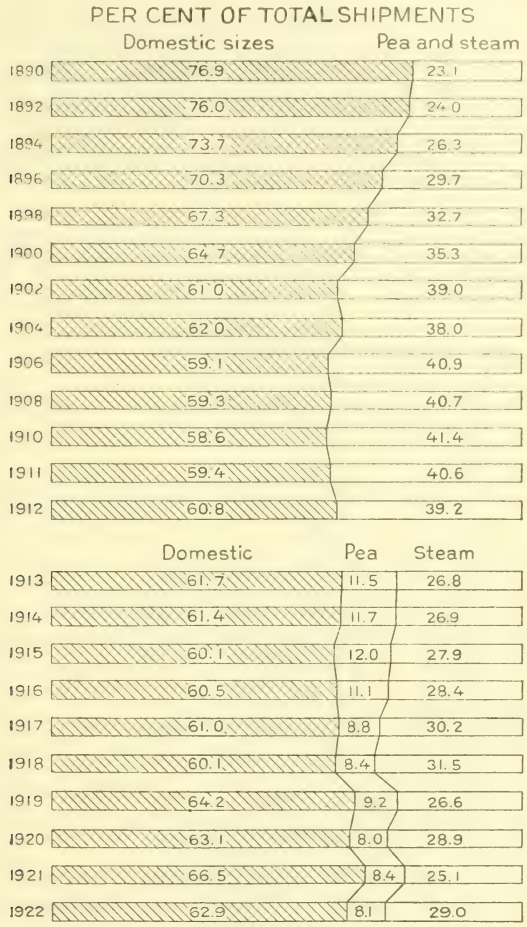


FIGURE 29.—Sizes of anthracite shipped from mines and washeries, 1890–1922. (Shipments from Sullivan County and dredges not included.)

62 washeries, and 60 dredges. In 1921 the prices of the steam sizes declined notably, and the number of breakers and washeries in operation also declined. In 1922 there was a further decline in the number of breakers but an increase in the number of washeries, bringing the total number of operations back to the figure of 1920 but less than the total of 1919.

Number of anthracite breakers, washeries, and dredges active in 1918–1922.

	1918	1919	1920	1921	1922
Lehigh:					
Breakers	34	34	36	33	32
Washeries	11	12	10	11	11
Dredges	0	3	3	1	4
	45	49	49	45	47
Schuykill:					
Breakers	78	80	78	79	78
Washeries	25	24	19	17	24
Dredges	31	74	56	59	56
	134	178	153	155	158
Wyoming:					
Breakers	139	142	135	130	131
Washeries	40	42	33	27	34
Dredges	1	3	1	2	2
	180	187	169	159	167
Sullivan County:					
Breakers	3	3	3	3	2
Total breakers	254	259	252	245	243
Total washeries	76	78	62	55	69
Total dredges	32	80	60	62	62
Grand total	362	417	374	362	374

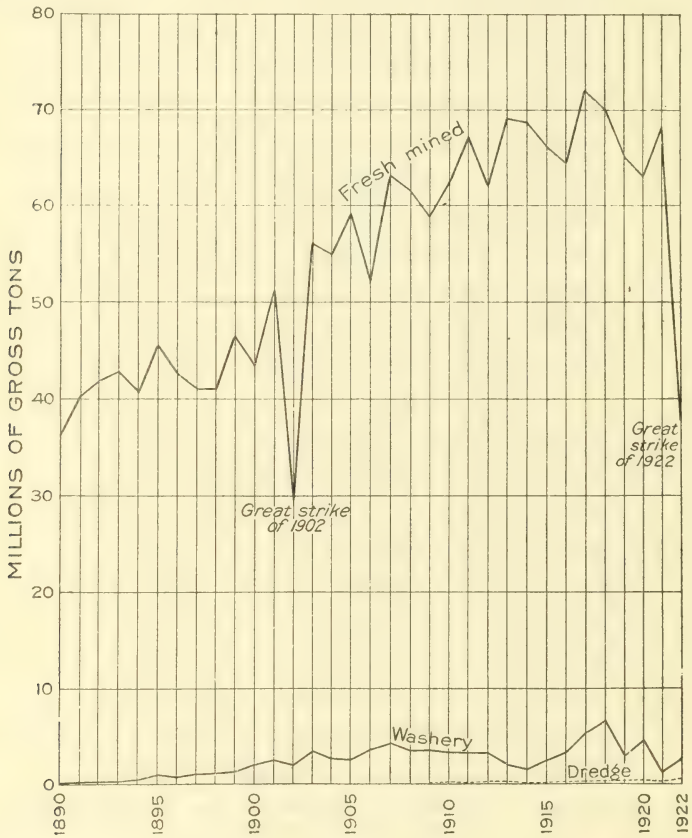


FIGURE 30.—Anthracite shipped from mines, washeries, and dredges, 1890–1922. (Includes Sullivan County.)

LABOR STATISTICS.

Statistics of labor employed in the production of anthracite in Pennsylvania in 1921 and 1922 are given in the following tables. The increase in the working force made in 1921 over 1920 (from 145,074 to 159,499 men) was partly wiped out in 1922, when the total number employed dropped to 156,849, as compared with the maximum of 179,679 in 1914. Except that of 1921, however, the total of 1922 was the largest since 1916. The average daily output per man in 1922 was 2.31 net tons—the largest average since 1908.

The average in 1921 was 2.09 tons. As in 1919 and 1920, the daily average in 1922 was increased by the large output of reclaimed coal. If the output of the washeries and dredges and the number of men employed by them are excluded, the average daily output per man in 1922 was 2.16 net tons, as compared with 2.05 tons in 1921 and 2.13 tons in 1920.

In considering the productivity of labor in the anthracite region it must be remembered that the work of preparing hard coal for the market is much more complicated than that of preparing soft coal. Hence the percentage of men necessarily employed above ground in the anthracite field is larger than in the bituminous-coal fields. From 1919 to 1922 the percentage of underground employees in the bituminous-coal fields increased from 81.8 to 84.6, and the percentage of underground employees in the anthracite regions increased from 69.8 to 72.8. Other facts to be considered in interpreting the average production per man per day are considered on page 505.

Men employed and days worked in the anthracite field in 1921 and 1922, by regions.

Region.	Average number of men employed.					Average number of days worked.
	Surface.	Underground.			Total.	
		Miners.[a]	All others.	Total.		
1921.						
Lehigh:						
Freshly mined coal	6,738	7,732	6,154	13,886	20,624	270
Washery product	96				96	224
Dredge product	7				7	155
	6,841	7,732	6,154	13,886	20,727	270
Schuylkill:						
Freshly mined coal	15,566	21,341	11,819	33,160	48,726	278
Washery product	744				744	86
Dredge product	291				291	180
	16,601	21,341	11,819	33,160	49,761	274
Wyoming:						
Freshly mined coal	18,413	44,484	24,813	69,297	87,710	270
Washery product	515				515	144
Dredge product	15				15	120
	18,943	44,484	24,813	69,297	88,240	269
Sullivan County:						
Freshly mined coal	297	420	54	474	771	206
Total freshly mined coal	[b]41,014	73,977	42,840	116,817	157,831	272
Total washery product	1,355				1,355	118
Total dredge product	313				313	176
Grand total	42,682	73,977	42,840	116,817	159,499	271
1922.						
Lehigh:						
Freshly mined coal	6,160	8,127	5,647	13,774	19,934	157
Washery product	228				228	99
Dredge product	18				18	125
	6,406	8,127	5,647	13,774	20,180	156
Schuylkill:						
Freshly mined coal	15,448	20,909	12,038	32,947	48,395	156
Washery product	1,016				1,016	130
Dredge product	311				311	174
	16,775	20,909	12,038	32,947	49,722	155
Wyoming:						
Freshly mined coal	18,436	43,163	23,909	67,072	85,508	147
Washery product	678				678	156
Dredge product	19				19	131
	19,133	43,163	23,909	67,072	86,205	147
Sullivan County:						
Freshly mined coal	256	328	158	486	742	113
Total freshly mined coal	[b]40,300	72,527	41,752	114,279	154,579	151
Total washery product	1,922				1,922	136
Total dredge product	348				348	169
Grand total	42,570	72,527	41,752	114,279	156,849	151

[a] Operators were requested to give number of "all miners (contract, consideration, and company) and their laborers."

[b] Includes a comparatively small number of washery employees who could not be separated from breaker employees.

Employees of dredge operations.—The activity of the river dredges varies with the state of navigation and with the demand for coal. In January, 1922, there were 138 men employed on the dredges, but by midsummer the number had risen to 492, only to fall again to 190 in December. The average number of employees for the year was 348.

From the monthly record of men employed given in the following table, it will be seen that the dredges continued to operate during the strike. In fact, only two of the dredge operations lost men during the strike. At these two dredges, both of which were in the Schuylkill region, four men were out for 140 days.

Number of employees on payrolls of anthracite dredge operations on the first day of each month, 1922.

	Lehigh district.	Schuylkill district.	Wyoming district.	Total.		Lehigh district.	Schuylkill district.	Wyoming district.	Total.
January		121	17	138	August	20	431	20	471
February		139	17	156	September	50	416	20	486
March		251	17	268	October	39	286	17	342
April	7	343	17	367	November	34	216	17	267
May	10	411	17	438	December	10	163	17	190
June	20	429	26	475					
July	18	449	25	492	Average	18	311	19	348

During the five years from 1918 to 1922 there were two extensive strikes in the anthracite region. The first was the "vacation" strike in September, 1920, when about 60 per cent of the miners quit work in protest over the wage award of the Anthracite Coal Commission, appointed by the President of the United States after the operators and the miners had been unable to come to an agreement by direct negotiations. In 1922 the men were out from April 1 to September 9, inclusive, when direct negotiations again broke down. Unlike the 1920 walkout, however, the later suspension did not come after the fixing of a new wage agreement but in the absence of one.

Strikes and lockouts in the Pennsylvania anthracite region, 1918–1922.

District.	1918		1919		1920		1921		1922	
	Days.	Men.	Days.	Men.	Days.	Men.	Days.	Men.	Days.	Men.
Lehigh	2	1,092	4	6,518	15	15,666	18	10,847	137	19,066
Schuylkill	4	9,945	4	4,212	17	41,945	5	5,523	137	41,893
Wyoming	4	7,785	8	24,409	23	39,229	17	35,747	138	80,753
Sullivan County	2	468							144	730
	4	19,290	7	35,139	19	96,840	16	52,117	138	142,442

METHODS OF MINING.

Machine mining of anthracite was confined to the Wyoming region and Sullivan County during the year covered by this report. In 1920 the quantity so mined was 837,565 gross tons. In 1921 it increased to 874,237 gross tons, an output made by 114 mining machines, of which 97 were at work in the Wyoming region and 17 in Sullivan County. In 1922 the quantity dropped to 448,922

gross tons, produced by 82 machines in the Wyoming region; no machine production was reported from Sullivan County that year.

Strip-pit mining is carried on in all three of the major regions. In 1920 the number of steam and electric shovels is use was 96 and the output was 1,834,322 gross tons; in 1921 the number of shovels dropped to 85 and their output to 1,810,527 gross tons; and in 1922 only 69 shovels were working, producing 847,987 gross tons.

Pennsylvania anthracite mined by machines in 1920–1922.

Region.	1920		1921		1922	
	Number of machines.	Gross tons.	Number of machines.	Gross tons.	Number of machines.	Gross tons.
Wyoming	125	566,356	97	636,021	82	448,922
Sullivan County	14	271,209	17	238,216		
	139	837,565	114	874,237	82	448,922

Pennsylvania anthracite recovered from steam-shovel strip pits in 1920–1922.

Region.	1920		1921		1922	
	Number of shovels.	Gross tons.	Number of shovels.	Gross tons.	Number of shovels.	Gross tons.
Lehigh	37	1,032,170	29	865,877	33	453,727
Schuylkill	30	574,982	34	680,869	24	345,815
Wyoming	29	227,170	22	263,781	12	48,445
	96	1,834,322	85	1,810,527	69	847,987

VALUE OF ANTHRACITE PRODUCED AND SHIPPED.

The value of the anthracite shipped as reported to the Geological Survey is its value at the breaker less losses through depreciation and the cost of selling. In order to determine the average value per ton for each size the proceeds of the sale of coal of each size are reported, and these amounts are divided by the total number of tons of that size shipped.

A comparison of production in 1922 and 1921 shows a decline of 39.6 per cent in quantity and 39.5 per cent in value. In other words, the decline in quantity was only 0.1 per cent greater than the decline in value. This is a relationship approaching perfect constancy unmatched in any of the bituminous-coal fields of the country in the same two years. Translated into terms of dollars and cents it meant that the average value per ton for all coal produced in 1922 was only 1 cent greater than in 1921. One cent was also the total increase in the average value of anthracite loaded for shipment. The average on local sales, however, increased from $4.75 to $5.07 a gross ton and that on mine fuel from $1.08 to $1.38 a ton. The latter increase, of course, was a bookkeeping advance.

The Wyoming region alone showed an increase in the average price per ton on coal loaded for shipment. That increase was 23 cents, and was sufficient to offset the losses in the Lehigh and Schuylkill regions and in Sullivan County. Every region, including the Bernice Basin, showed increased average values on local sales, and Sullivan County was the only district to report a lower average on coal used at the mines.

The average value per ton by sizes on total shipments in 1922 showed increases for every size except boiler coal. The average on lump rose from $7.01 to $7.70 per gross ton; broken, from $7.37 to $7.65; egg, from $7.42 to $7.91; chestnut, from $7.66 to $8.07; stove, from $7.67 to $8.03; pea, from $5.74 to $5.92; No. 1 buckwheat, from $3.42 to $3.55; rice, from $2.27 to $2.37; barley, from $1.44 to $1.57. The average on boiler coal declined from $1.82 to $1.49 per gross ton.

The insignificant increase in the average value per ton for all sizes as compared with the substantial increases in the averages on most of the individual sizes was due to the fact that the proportion of steam sizes produced and shipped was greater in 1922 than in 1921. Moreover, in studying the fluctuations in the values reported for the individual sizes consideration must be given to certain factors not disclosed in the tables that follow. Over 75 per cent of the anthracite mined is the product of the "old line" or "railroad" coal companies. (See p. 453.) This group maintains a price stability upon the domestic sizes that is little affected by seasonal changes in market conditions or by unforeseen changes in demand or supply. The smaller operators, whose title to a differential over "company" prices was confirmed by the United States Fuel Administration in the Federal war-time anthracite price schedules, follow selling policies that give full recognition to the law of supply and demand, although in recent years they have been less disposed to make prices below "company" circulars in order to move tonnage during periods of weak demand, except upon steam sizes.

In addition to the normal stabilizing influence on prices exercised by the major group of producers, there was also extra-legal price control on domestic sizes during the last three and one-half months of the year. With the termination of the strike the Pennsylvania Fuel Commission, a nonstatutory body created by the governor, took steps to control prices and distribution of the domestic anthracite mined. This commission fixed a base maximum price of $8.50 per gross ton f. o. b. mines and then appointed a fair-practices committee to consider the cases of those operators who felt that their costs of production warranted greater maxima. According to the Federal Fuel Distributor, who in effect delegated whatever powers he had over anthracite to the Pennsylvania commission, the State body was able to obtain the cooperation of over 98.5 per cent of the anthracite industry in the observance of rules and prices formulated by it.[8]

"The following table," according to a statement of the chairman of the committee, "shows the prices of domestic sizes of anthracite found fair by the fair-practices committee with the percentage of

[8] Federal Fuel Distributor Final Rept., p. 13, 1923.

the total production sold at the specified price or less, the production figures being those of the previous year."

Price per gross ton.	Percentage of total tonnage affected.	Price per gross ton.	Percentage of total tonnage affected.
Not to exceed $8.50	77.464	Above $10.00 but not exceeding $10.50	2.519
Above $8.50 but not exceeding $9.25	11.267	Above $10.50 but not exceeding $11.00	2.120
Above $9.25 but not exceeding $9.50	.093	Above $11.00 but not exceeding $12.00	1.402
Above $9.50 but not exceeding $10.00	2.675		

"As far as the information of the committee goes," continues the statement, "the prices found fair by them have been faithfully followed by the anthracite producers with but few exceptions." [9]

A comparison of these prices with the values shown in the second table following emphasizes the strength of the major producing group in pulling down the average values for the tonnage as a whole.

Average value per gross ton of anthracite shipped, local sales, mine fuel, and total production, by regions, 1917–1922.

Year and region.	Shipments.	Local trade.	Mine fuel.	Total	Year and region.	Shipments.	Local trade.	Mine fuel.	Total
1917.					**1920.**				
Lehigh	$3.44	$2.20	$1.10	$3.18	Lehigh	$5.88	$3.29	$1.94	$5.34
Schuylkill	3.48	2.82	.72	3.08	Schuylkill	5.70	4.14	.90	4.99
Wyoming	3.48	3.03	.99	3.25	Wyoming	6.15	5.17	1.80	5.71
Sullivan County	2.95	3.44	1.03	2.85	Sullivan County	5.60	5.71	2.33	5.27
	3.47	2.85	.90	3.19		5.97	4.44	1.47	5.43
1918.					**1921.**				
Lehigh	4.01	2.68	1.36	3.71	Lehigh	6.13	3.50	1.59	5.54
Schuylkill	4.13	3.33	.91	3.67	Schuylkill	6.03	4.19	.65	5.22
Wyoming	4.18	3.39	1.45	3.92	Wyoming	6.29	5.64	1.27	5.82
Sullivan County	3.97	3.99	2.29	3.79	Sullivan County	6.21	6.20	2.30	5.53
	4.14	3.25	1.23	3.81		6.20	4.75	1.08	5.60
1919.					**1922.**				
Lehigh	4.86	3.37	1.80	4.51	Lehigh	6.05	3.97	2.34	5.56
Schuylkill	4.94	3.43	.85	4.31	Schuylkill	5.78	4.44	.78	4.98
Wyoming	5.21	4.55	1.55	4.85	Wyoming	6.52	5.78	1.69	6.02
Sullivan County	4.63	4.70	2.29	4.36	Sullivan County	5.22	6.18	2.00	4.84
	5.08	3.98	1.32	4.64		6.21	5.07	1.38	5.61

[9] Quoted in "The anthracite emergency of 1922–23 and how it was handled," brief submitted to the United States Coal Commission on behalf of the General Policies Committee of Anthracite Operators, pp. 13–14.

Anthracite shipped in 1921 and 1922, by regions and sizes, in gross tons.

Size.	Lehigh region.			Schuylkill region.			Wyoming region.			Sullivan County (mines).	Total.	
	Mines.	Washeries.	Dredges.	Mines.	Washeries.	Dredges.	Mines.	Washeries.	Dredges.		Quantity.	Percentage of total.
1921.												
Lump				9,703			2,627				12,330	
Broken	174,262	1,145		641,957	3,507		1,643,335	68		10,416	2,474,690	3.6
Egg	1,307,612	12,221		2,520,409	5,496		6,361,616	6,990		25,515	10,239,859	14.7
Stove	1,757,426	16,293		3,793,819	4,991		9,035,728	35,344		44,037	14,687,638	21.1
Chestnut	2,358,864	38,244		4,807,884	53,948		11,235,371	76,837		65,534	18,636,682	26.8
Pea	981,552	26,596	865	2,020,455	47,060	28	2,684,236	68,646	1,280	34,661	5,865,379	8.4
Buckwheat No. 1	1,233,111	28,518	1,165	3,347,167	103,958	40,423	4,479,479	113,228	1,960		9,349,009	13.4
Buckwheat No. 2 (rice)	598,681	29,082		1,151,726	90,587	2,915	2,508,298	134,325			4,515,614	6.5
Buckwheat No. 3 (barley)	563,106	89,537	19,569	1,043,122	130,317	40,680	1,128,820	146,368	3,199		3,164,718	4.6
Boiler	15,493	1,308		4,985	21	68,799	147,082	29,748	10,760		278,196	.4
Other [a]	102,595			41,638	9,505	73,068	41,571	4,548		57,523	330,448	.5
	9,092,702	242,944	21,599	19,382,865	449,390	225,913	39,268,163	616,102	17,199	237,686	69,554,563	100.0
1922.												
Lump				4,151							4,151	
Broken	95,624	870		388,775	3,805		1,139,319	2,072		8,809	1,639,274	4.0
Egg	676,811	5,756		1,244,818	5,347		3,533,052	7,794		13,453	5,487,031	13.4
Stove	1,001,658	3,821		2,202,377	9,690		4,929,689	25,162		20,910	8,193,307	19.9
Chestnut	1,349,259	47,902		2,754,717	126,935		5,650,905	123,890		32,352	[b] 10,085,960	24.6
Pea	602,358	19,734	979	977,718	211,724	487	1,368,144	75,726	2,131	19,135	3,278,136	8.0
Buckwheat No. 1	782,840	22,618	2,210	1,782,928	417,811	1,368	2,381,500	143,835	2,485		5,537,595	13.5
Buckwheat No. 2 (rice)	415,009	22,329	111	689,348	259,696	30,220	1,378,857	179,421	1,296		[c] 2,976,287	7.2
Buckwheat No. 3 (barley)	358,097	103,682	26,547	858,334	443,401	89,937	745,350	216,527			2,841,875	6.9
Boiler	13,776		61,281	22,039	1,638	33,405	92,757	6,297	40,324		271,517	.7
Other [d]	37,840	15,721		105,643	66,648	274,073	112,331	30,629		115,820	758,705	1.8
	5,333,272	242,433	91,128	11,030,848	1,546,695	429,490	21,331,904	811,353	46,236	210,479	41,073,838	100.0

[a] Includes quantity reported as culm, buckwheat No. 4, screenings, settlings, silt, mine run, dirt, and slush.
[b] Includes 579,898 tons of "range" coal, reported by 8 operators.
[c] Includes 581,557 tons of "birdseye" coal, reported by 11 operators.
[d] Includes run of mine, silt, culm, No. 4 buckwheat, and screenings.

Value of anthracite shipped in 1921, by regions and sizes.

Size.	Lehigh region.						Schuylkill region.					
	Mines.		Washeries.		Dredges.		Mines.		Washeries.		Dredges.	
	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.
Lump							$72,768	$7.50				
Broken	$1,308,653	$7.51	$8,326	$7.27			4,983,053	7.76	$27,090	$7.72		
Egg	10,042,861	7.68	91,236	7.47			19,234,895	7.63	41,064	7.47		
Stove	13,946,710	7.94	131,046	8.04			29,647,890	7.81	39,915	8.00		
Chestnut	18,557,999	7.87	304,531	7.96			38,074,078	7.92	394,674	7.32		
Pea	5,812,210	5.92	161,178	6.06	$2,890	$3.34	11,710,372	5.80	259,573	5.52	$56	$2.00
Buckwheat No. 1	4,305,755	3.49	101,947	3.57	2,562	2.20	11,508,711	3.44	348,767	3.35	49,244	1.22
Buckwheat No. 2 (rice)	1,437,219	2.40	68,509	2.36			2,558,390	2.22	212,845	2.35	3,627	1.24
Buckwheat No. 3 (barley)	868,234	1.54	146,143	1.63	21,884	1.12	1,425,757	1.37	184,536	1.42	33,554	.82
Boiler	15,481	1.00	3,159	2.42			12,110	2.43	39	1.86	67,702	.98
Other	49,173	.48					31,086	.75	6,605	.69	65,827	.90
	56,344,295	6.20	1,016,075	4.18	27,336	1.27	119,259,110	6.15	1,515,108	3.37	220,010	.97

Size.	Wyoming region.						Sullivan County.		All regions.	
	Mines.		Washeries.		Dredges.		Mines.		Total.	Average per ton.
	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.		
Lump	$13,683	$5.21							$86,451	$7.01
Broken	11,839,868	7.20	$553	$8.13			$77,715	$7.46	18,245,258	7.37
Egg	46,329,198	7.28	47,591	6.81			191,176	7.49	75,978,021	7.42
Stove	68,305,209	7.56	262,090	7.42			338,167	7.68	112,671,027	7.67
Chestnut	84,281,697	7.50	548,017	7.13			504,408	7.70	142,665,404	7.66
Pea	15,130,474	5.64	384,487	5.60	$7,040	$5.50	204,683	5.91	33,672,963	5.74
Buckwheat No. 1	15,247,964	3.40	401,797	3.55	4,900	2.50			31,971,647	3.42
Buckwheat No. 2 (rice)	5,650,883	2.25	304,732	2.27					10,236,205	2.27
Buckwheat No. 3 (barley)	1,665,024	1.48	214,807	1.47	10,339	3.23			4,570,278	1.44
Boiler	336,690	2.29	60,518	2.03	10,836	1.01			506,535	1.82
Other	66,202	1.59	7,882	1.73			159,314	2.77	386,089	1.17
	248,866,892	6.34	2,232,474	3.62	33,115	1.93	1,475,463	6.21	430,989,878	6.20

Value of anthracite shipped in 1922, by regions and sizes.

Size.	Lehigh region.						Schuylkill region.					
	Mines.		Washeries.		Dredges.		Mines.		Washeries.		Dredges.	
	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.
Lump							$31,966	$7.70				
Broken	$739,087	$7.73	$6,656	$7.65			3,226,665	8.30	$32,034	$8.42		
Egg	5,433,193	8.03	46,455	8.07			10,111,286	8.12	43,988	8.23		
Stove	8,074,057	8.06	31,210	8.17			18,214,259	8.27	78,828	8.13		
Chestnut	10,830,492	8.03	395,306	8.25			22,806,387	8.28	1,056,231	8.32		
Pea	3,571,003	5.93	121,868	6.18	$5,140	$5.25	5,934,244	6.07	1,247,669	5.89	$2,633	$5.41
Buckwheat, No. 1	2,866,769	3.66	87,573	3.87	4,745	2.15	6,242,872	3.50	1,422,273	3.40	3,855	2.82
Buckwheat No. 2 (rice)	1,061,351	2.55	60,834	2.72	302	2.72	1,578,288	2.29	584,536	2.25	61,310	2.03
Buckwheat No. 3 (barley)	626,324	1.75	184,716	1.78	36,423	1.15	1,285,025	1.50	653,780	1.47	104,036	1.16
Boiler	4,728	.34			65,707	1.07	9,717	.44	2,051	1.25	37,586	1.12
Other	33,553	.89	11,703	.74			54,623	.52	52,533	.79	296,418	1.08
	33,240,557	6.23	946,321	3.90	106,317	1.17	69,495,332	6.30	5,173,923	3.34	505,838	1.18

Size.	Wyoming region.						Sullivan County.		All regions.	
	Mines.		Washeries.		Dredges.		Mines.		Total.	Average per ton.
	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.	Total.	Average per ton.		
Lump									$31,966	$7.70
Broken	$8,456,611	$7.42	$14,828	$7.16			$64,106	$7.28	12,539,987	7.65
Egg	27,572,571	7.80	58,937	7.56			131,322	9.76	43,397,752	7.91
Stove	38,984,301	7.91	229,291	9.11			183,738	8.79	65,795,684	8.03
Chestnut	44,999,440	7.96	1,010,671	8.16			306,237	9.46	[a] 81,404,764	8.07
Pea	7,941,025	5.80	447,187	5.91	$11,802	$5.54	133,279	6.97	19,415,850	5.92
Buckwheat No. 1	8,523,555	3.58	516,810	3.59	7,688	3.09			19,676,140	3.55
Buckwheat No. 2 (rice)	3,240,995	2.35	472,224	2.63	662	.51			[b] 7,060,502	2.37
Buckwheat No. 3 (barley)	1,172,117	1.57	393,717	1.82					4,450,138	1.57
Boiler	193,762	2.09	16,224	2.58	74,040	1.84			403,815	1.49
Other	217,561	1.94	31,482	1.03			280,067	2.42	977,940	1.29
	141,301,938	6.62	3,191,371	3.93	94,192	2.04	1,098,749	5.22	255,154,538	6.21

[a] Includes $5,288,017, value of "range" coal.
[b] Includes $1,342,528, value of "birdseye."

BITUMINOUS COAL.

In 1922 the production of bituminous coal in Pennsylvania amounted to 113,148,308 net tons, valued at $351,777,000. This was the smallest output made by the State since 1904. Compared with that of 1921 it showed a decrease of 2,865,634 tons, or 2.5 per cent, in quantity, but an increase of $29,238,700, or 9.1 per cent, in value. The increased value, of course, was due to higher prices. The average value per ton for all producing counties increased from $2.78 to $3.11. Every county except Lawrence and Bradford shared in this increase.

Pennsylvania was one of the storm centers of the bituminous coal strike of 1922. It is not only by far the largest producer of bituminous coal in the country, but, like West Virginia, it offers an interesting study of the effect of labor organization. In the western part of the State, centering around Pittsburgh, is one of the union strongholds of the country. Indeed, for a quarter of a century this area has been a part of the central competitive field. Adjacent to the unionized western district are the Connellsville coking district and the Westmoreland gas-coal district, both long considered nonunion strongholds. In the great central Pennsylvania field there are both union and nonunion operations. The competition of coal from the organized portions of central Pennsylvania with coal from nonunion mines in the same region and with nonunion West Virginia coal has led operators in the organized part of that district to urge a wage adjustment with the United Mine Workers of America that will be framed with a view of meeting the nonunion competition and not, as at present, be subject to the contracts entered into between the union and the operators in the central competitive field (Illinois, Indiana, Ohio, and western Pennsylvania).

Because of this variation in union affiliations the most interesting aspect of the production of bituminous coal in Pennsylvania in 1922 is found not in the course of the output of the State as a whole but in the changes in the individual counties and producing districts. In comparing the figures with those for 1921, however, it is important to remember that the depression of 1921 had the effect of minimizing the losses in output in 1922 in the unionized districts and of magnifying the gains in the nonunion fields. In other words, were the comparison made between 1922 and a year of active demand, the losses due to the strike would appear much greater. This statement, of course, applies not only to Pennsylvania but to every bituminous-coal producing State.

The declaration of the strike not only tied up production in the western part of the State and in the established union areas in central Pennsylvania, but an unexpected response of the nonunion mines to the invitation to join in the strike for a time threw the nonunion strongholds of Connellsville, Westmoreland, Somerset, and South Fork-Windber into the strike zone. The walkout in the Connellsville region is reflected in the figures of production for Fayette County, where the output dropped 1,501,002 net tons below that of 1921, notwithstanding the pronounced recovery in the demand for beehive coke. Production in nonunion Somerset County and semiorganized Cambria County, in which the South Fork-Windber district is included, also suffered. Somerset County showed a

decline of 1,347,556 tons; Cambria, 3,381,913 tons—a heavier loss than that for any other county. Allegheny County (western Pennsylvania) lost 908,316 tons. Washington County, which lies in the central competitive field, lost 2,144,507 tons. The greatest increase was in Westmoreland County, where the output was 20,639,693 tons, or 2,573,295 tons greater than in 1921. Westmoreland County ranked first in total output in the Pennsylvania bituminous fields; Fayette County ranked second.

The average working time for the State as a whole was 154 days. The variation between different counties was naturally great on account of the situation outlined in the preceding paragraphs. At the bottom of the list was union Bedford County, with an average of 92 days; at the top Lawrence County, with an average of 253 days. Neither county, however, looms large in total production. The average output per man per day for the State dropped from 4.03 to 3.84 tons. There was a slight decline in the total number of workers and a still larger decrease in the number of underground tonnage men.

Bituminous coal produced in Pennsylvania in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
								Miners.[a]	All others.			
1921.[b]												
Allegheny	10,513,579	1,201,262	216,064	622	11,931,527	$34,877,000	$2.92	13,992	4,420	2,662	21,074	146
Armstrong	3,026,839	212,159	149,764		3,388,762	10,369,000	3.06	4,784	1,713	1,080	7,577	121
Beaver	121,073	40,306	30		161,409	413,100	2.56	180	27	73	280	195
Bedford	201,099	43,178	8,885	64,082	317,244	1,052,000	3.32	749	272	139	1,160	81
Blair	73,418	18,161	565		92,144	286,000	3.10	220	66	35	321	106
Bradford, Fulton, Lycoming, and McKean	50,369	4,492	435		55,296	203,200	3.67	88	24	26	138	137
Butler	856,061	50,918	16,412		923,391	2,366,000	2.56	1,434	409	326	2,169	129
Cambria	14,541,992	1,061,642	212,839	522,755	16,339,228	49,769,000	3.05	16,873	4,952	2,788	24,613	165
Center	691,723	69,740	3,531		764,994	2,334,000	3.05	1,538	384	253	2,175	111
Clarion	1,151,474	79,749	17,071		1,248,294	3,495,000	2.80	1,917	556	346	2,819	151
Clearfield	5,486,633	209,543	115,540	42,206	5,853,922	16,691,000	2.85	8,705	2,487	1,477	12,669	143
Clinton	59,571	23,560	510		83,641	252,000	3.01	192	61	65	318	75
Elk	838,947	21,968	17,286		878,201	2,705,000	3.08	1,517	295	234	2,046	167
Fayette	13,799,565	234,090	630,965	4,596,158	19,260,778	46,041,000	2.39	11,960	9,323	4,901	26,184	150
Greene	2,228,672	20,956	45,173		2,294,801	5,935,000	2.59	1,414	804	637	2,855	244
Huntingdon	428,373	8,462	16,181	30,992	484,008	1,641,000	3.39	1,051	243	146	1,440	123
Indiana	5,964,908	108,353	153,562	131,148	6,357,971	18,431,000	2.90	8,859	2,786	1,735	13,380	131
Jefferson	2,318,151	74,490	142,294	172,959	2,707,894	8,160,000	3.01	4,045	1,157	789	5,991	132
Lawrence	174,157	9,601	9,899		193,657	584,000	3.01	189	90	42	321	274
Mercer	450,783	4,504	24,600		479,887	1,414,000	2.95	554	263	146	963	171
Somerset	8,623,857	195,061	156,891		8,975,809	26,021,000	2.90	8,730	2,732	1,670	13,132	173
Tioga	410,859	17,551	9,292		437,702	1,720,000	3.93	833	187	195	1,215	166
Washington	14,169,333	245,336	214,845	87,470	14,716,984	38,954,000	2.65	15,242	4,915	2,667	22,824	144
Westmoreland	15,843,904	360,508	389,738	1,472,248	18,066,398	48,825,000	2.70	14,752	6,238	3,989	24,979	164
	102,025,340	4,315,590	2,552,372	7,120,640	116,013,942	322,538,300	2.78	119,818	44,404	26,421	190,643	151

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Bituminous coal produced in Pennsylvania in 1921 and 1922—Continued.

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
								Miners.[a]	All others.			
1922.												
Allegheny	9,133,964	1,751,229	138,018		11,023,211	$35,726,000	$3.24	12,306	4,379	2,954	19,639	129
Armstrong	2,950,159	224,952	90,737		3,265,848	10,252,000	3.14	4,866	1,280	1,121	7,267	118
Beaver	167,210	39,554	20,195		226,959	769,000	3.39	205	32	106	343	218
Bedford	293,663	12,795	10,112	23,864	340,434	1,242,000	3.65	839	325	210	1,374	92
Blair	67,334	12,835	1,252	16,785	98,206	321,000	3.27	219	57	30	306	110
Bradford	6,480	1,404	20		7,904	26,000	3.35	12	4	6	22	156
Butler	1,751,428	57,529	29,004		1,837,961	6,353,000	3.46	1,816	543	417	2,776	201
Cambria	10,802,775	1,007,287	168,469	978,784	12,957,315	43,761,000	3.38	15,514	4,981	2,908	23,403	139
Center	1,154,406	48,865	4,588		1,207,859	3,776,000	3.13	1,620	426	273	2,319	143
Clarion	1,165,537	133,640	21,292		1,320,469	4,265,000	3.23	2,047	514	390	2,951	144
Clearfield	5,116,864	204,338	80,572	54,585	5,456,359	17,437,000	3.20	8,780	2,377	1,528	12,685	120
Clinton	112,609	31,854	1,687		146,150	508,000	3.48	207	66	62	335	172
Elk	815,089	10,819	29,197		855,105	2,717,000	3.19	1,247	283	257	1,787	131
Fayette	11,590,168	225,224	600,367	5,344,017	17,759,776	49,876,000	2.81	11,651	9,598	5,712	26,961	187
Greene	2,274,886	27,988	45,653		2,348,527	7,443,000	3.17	1,244	1,256	628	3,128	229
Huntingdon	381,056	6,530	9,564		397,150	1,818,000	4.58	1,009	273	141	1,423	93
Indiana	7,118,153	137,469	100,209	265,000	7,620,831	23,645,000	3.10	8,771	2,513	1,729	13,013	148
Jefferson	2,513,177	100,520	83,125	203,613	2,900,435	9,868,000	3.40	3,990	1,065	765	5,820	136
Lawrence	174,362	24,827	9,718		208,907	587,000	2.81	206	75	44	325	253
Mercer	429,859	6,042	21,552		457,453	1,438,000	3.14	664	215	115	994	181
Somerset	7,312,316	188,307	127,630		7,628,253	25,151,000	3.30	7,466	2,485	1,690	11,641	185
Tioga	338,520	28,508	7,126		374,154	1,476,000	3.95	898	165	163	1,226	131
Washington	12,070,000	298,088	188,296	16,093	12,572,477	37,103,000	2.95	15,333	5,510	3,387	24,230	115
Westmoreland	15,708,165	545,098	425,700	3,960,730	20,639,693	58,898,000	2.85	13,544	6,463	4,735	24,742	201
Other counties[c]	45,328	4,846	508		50,682	235,000	4.64	87	25	16	128	140
Total, excluding wagon mines	93,493,508	5,130,548	2,214,591	10,863,471	111,702,118	344,691,000	3.09	114,541	44,910	29,387	188,838	154
Wagon mines served by rail	1,446,190				1,446,190	7,086,000	4.90					
Grand total	94,939,698	5,130,548	2,214,591	10,863,471	113,148,308	351,777,000	3.11					

[a] Includes also loaders and shot firers.
[c] Cameron, Fulton, Lycoming, and McKean.

Bituminous coal produced in Pennsylvania, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease 1922.
Allegheny	17,375,035	14,856,781	16,047,575	11,931,527	11,023,211	−908,316
Armstrong	6,051,753	4,665,232	5,975,063	3,388,762	3,265,848	−122,914
Beaver	128,572	139,294	170,900	161,409	226,959	+65,550
Bedford	1,050,528	704,289	785,903	317,244	340,434	+23,190
Blair	279,817	181,209	158,257	92,144	98,206	+6,062
Bradford	[a] 31,299	[a] 13,373	[a] 67,932	[a] 55,296	7,904	(a)
Butler	1,397,927	1,128,192	1,542,307	923,391	1,837,961	+914,570
Cambria	20,569,253	16,899,818	18,967,754	16,339,228	12,957,315	−3,381,913
Cameron and McKean [b]	7,483	(c)	----------	(a)	[b] 50,682	+[b] 3,290
Center	1,984,664	1,296,061	1,735,045	764,994	1,207,859	+412,865
Clarion	1,607,641	1,393,647	1,567,095	1,248,294	1,320,469	+72,175
Clearfield	9,376,429	7,573,392	9,242,416	5,853,922	5,456,359	−397,563
Clinton	360,123	288,100	327,296	83,641	146,150	+62,509
Elk	968,868	947,595	1,258,834	878,201	855,105	−23,096
Fayette	32,925,888	29,660,105	30,742,236	19,260,778	17,759,776	−1,501,002
Greene	1,269,425	1,423,118	2,078,835	2,294,801	2,348,527	+53,726
Huntingdon	1,371,562	833,690	839,613	484,008	397,150	−86,858
Indiana	12,743,190	8,526,404	11,414,048	6,357,971	7,620,831	+1,262,860
Jefferson	5,140,833	3,841,478	5,346,458	2,707,894	2,900,435	+192,541
Lawrence	107,086	140,054	157,934	193,657	208,907	+15,250
Mercer	690,785	481,521	530,427	479,887	457,453	−22,434
Somerset	10,264,083	10,433,752	10,532,967	8,975,809	7,628,253	−1,347,556
Tioga	834,385	593,637	763,611	437,702	374,154	−63,548
Washington	23,537,263	19,515,856	23,321,195	14,716,984	12,572,477	−2,144,507
Westmoreland	28,121,234	24,947,773	24,510,146	18,066,398	20,639,693	+2,573,295
Small mines	[c] 355,615	[c] 273,783	2,524,000	(d)	1,446,190	(d)
Total value	178,550,741	150,758,154	170,607,847	116,013,942	113,148,308	−2,865,634
	$463,159,736	$365,430,504	$642,630,000	$322,538,300	$351,777,000	+$29,238,700

[a] Bradford County includes Lycoming in 1918 and 1919; Fulton and Lycoming in 1920; and Fulton, Lycoming, and McKean in 1921.
[b] No production in Cameron County in 1918 and 1919; none in Cameron or McKean in 1920; none in Cameron in 1921; includes Fulton and Lycoming in 1922.
[c] Small mines include Fulton County in 1918 and Fulton and McKean in 1919.
[d] No canvass of wagon mines for 1921.

RHODE ISLAND.

A small quantity of graphitic anthracite was mined in Rhode Island in 1921 and used for fuel. The last year preceding of which the Geological Survey has record of any production in that State was 1912. The Survey received no information of production in the State for 1922. Many attempts have been made to develop the coal deposits of Rhode Island, but so far without commercial success. Bulletin 615 of the Geological Survey, "Rhode Island coal," by G. H. Ashley, describes the coal and gives a history of the attempts to mine and market it.

SOUTH DAKOTA.

The production of lignite in South Dakota showed little change in 1922, registering a gain of only 199 tons over the total of the preceding year. The bulk of the output is sold for local consumption. The operations are all small, and the average production per mine is about 500 tons a year. In this respect, as well as in distribution, the industry in South Dakota differs materially from that in the adjoining State of North Dakota.

Lignite produced in South Dakota in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Dewey and Harding	450	1,441	----------	1,891	$4,800	$2.54	16	----------	----------	16	139
Meade and Ziebach	----------	791	----------	791	2,300	2.91	6	----------	----------	6	83
Perkins	----------	4,837	34	4,871	14,100	2.89	21	----------	----------	21	135
	450	7,069	34	7,553	21,200	2.81	43	----------	----------	43	129
1922.											
Dewey and Harding	400	930	----------	1,330	$3,400	$2.56	6	----------	----------	6	154
Meade, Ziebach, and wagon mines	50	887	----------	937	3,600	3.84	5	----------	----------	5	109
Perkins	----------	5,485	----------	5,485	15,000	2.73	21	----------	----------	21	140
	450	7,302	----------	7,752	22,000	2.84	32	----------	----------	32	138

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Lignite produced in South Dakota, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease. 1922.
Dewey and Harding	[a] 2,579	[a] 5,991	6,119	1,891	1,330	−561
Meade	645	824	[a] 650	[a] 791	[b] 937	+146
Perkins	4,718	7,602	6,008	4,871	5,485	+614
	7,942	14,417	12,777	7,553	7,752	+199
Total value	$22,230	$45,707	$46,000	$21,200	$22,000	+$800

[a] Includes Ziebach County; no canvass of wagon mines for 1921.
[b] Includes Ziebach County and wagon mines.

TENNESSEE.

The production of coal in Tennessee in 1922 was 4,876,774 tons, valued at $14,096,000. Compared with the preceding year, this was an increase of 416,448 tons, or 9.3 per cent, in quantity, but a reduction of $836,000, or 5.6 per cent, in value. The average value per ton in 1922 was $2.89, a decline of 46 cents. The average number of days the mines were in operation increased from 154 to 163, but the average output per man per day declined 0.21 ton. There was an increase of over 10 per cent in the total number of employees, the greater part of whom were underground tonnage workers.

Coal produced in Tennessee in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				
								Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Miners.[a]	All others.	Surface.	Total.	Average number of days worked.
1921.[b]												
Anderson	317,207	8,944	7,265	.....	333,416	$987,000	$2.96	599	269	172	1,040	117
Campbell	989,685	23,877	30,475	.....	1,044,037	4,073,000	3.90	1,517	582	448	2,547	159
Claiborne	818,533	9,327	20,165	.....	848,025	2,872,000	3.39	702	344	202	1,248	189
Fentress	380,493	4,935	9,466	.....	394,894	1,156,000	2.93	408	84	95	587	140
Grundy	363,509	1,610	1,918	19,727	386,764	1,296,000	3.35	637	247	144	1,028	161
Marion	256,782	4,299	7,603	.....	268,684	787,000	2.93	271	119	144	534	172
Morgan	261,321	1,208	12,389	21,500	296,418	1,042,000	3.51	387	253	114	754	210
Overton	153,164	1,589	1,199	.....	155,952	555,000	3.56	175	41	34	250	118
Scott	106,034	7,212	590	.....	113,836	327,000	2.87	203	59	68	330	160
Other counties[c]	547,636	25,198	32,660	12,806	618,300	1,837,000	2.97	1,162	502	365	2,029	121
	4,194,364	88,199	123,730	54,033	4,460,326	14,932,000	3.35	6,061	2,500	1,786	10,347	154
1922.												
Anderson	602,596	8,802	18,340	.....	629,738	1,649,000	2.62	708	219	183	1,110	170
Bledsoe	44,125	879	1,000	.....	46,004	123,000	2.67	74	28	10	112	211
Campbell	1,100,714	33,850	21,919	.....	1,156,483	3,708,000	3.21	2,027	532	417	2,976	171
Claiborne	627,309	9,204	14,199	.....	650,712	1,934,000	2.97	789	370	316	1,475	118
Cumberland	9,676	174	787	.....	10,637	48,000	4.51	27	15	16	58	69
Fentress	300,822	5,703	10,342	.....	316,867	860,000	2.71	298	99	115	512	153
Grundy	305,652	1,075	2,322	24,800	333,849	1,021,000	3.06	815	249	148	1,212	174
Hamilton	191,093	8,385	11,658	.....	211,136	617,000	2.92	345	163	85	593	157
Marion	189,736	2,558	5,586	.....	197,880	489,000	2.47	287	138	112	537	154
Morgan	306,418	6,905	2,887	.....	316,210	813,000	2.57	436	241	127	804	195
Overton	170,767	.....	554	.....	171,321	440,000	2.57	184	40	35	259	138
Rhea	59,448	6,629	3,903	.....	69,980	178,000	2.54	175	97	88	360	115
Roane	4,220	14,709	5,347	79,591	103,867	294,000	2.83	99	86	35	220	239
Scott	136,983	8,197	473	.....	145,653	435,000	2.99	206	66	71	343	151
Sequatchie and White	452,622	4,907	14,537	.....	472,066	1,310,000	2.78	526	194	158	878	188
Total, excluding wagon mines	4,502,181	111,977	113,854	104,291	4,832,403	13,919,000	2.88	6,996	2,537	1,916	11,449	163
Wagon mines served by rail	44,371	.....	.....	.....	44,371	177,000	4.00	.....	.....	.....	.....	.....
Grand total	4,546,552	111,977	113,854	104,291	4,876,774	14,096,000	2.89	.....	.....	.....	.....	.....

[a] Includes also loaders and shot firers. [b] Exclusive of product of wagon mines. [c] Bledsoe, Cumberland, Hamilton, Rhea, Roane, Sequatchie, and White.

Coal produced in Tennessee, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Anderson	619,381	497,642	620,089	333,416	629,738	+296,322
Campbell	1,367,448	1,161,722	1,281,787	1,044,037	1,156,483	+112,446
Claiborne	1,345,914	1,077,772	1,157,281	848,025	650,712	−197,313
Cumberland	53,127	41,917	74,149	(a)	10,637	(a)
Fentress	474,331	353,428	552,274	394,894	316,867	−78,027
Grundy	432,623	378,447	612,183	386,764	333,849	−52,915
Hamilton	(a)	(a)	244,477	(a)	211,136	(a)
Marion	490,771	384,058	357,419	268,684	197,880	−70,804
Morgan	645,344	375,448	443,930	296,418	316,210	+19,792
Overton	227,392	(a)	(a)	155,952	171,321	+15,369
Roane	(a)	162,645	151,603	(a)	103,867	(a)
Scott	152,703	100,455	148,470	113,836	145,653	+31,817
Other counties a	1,015,912	678,066	941,966	618,300	588,050	+295,390
Small mines	6,102	1,605	76,800	(b)	44,371	(b)
Total value	6,831,048	5,213,205	6,662,428	4,460,326	4,876,774	−416,448
	$19,305,203	$14,448,168	$26,778,000	$14,932,000	$14,096,000	−$836,000

a Other counties include Bledsoe, Hamilton, Rhea, Roane, Sequatchie, and White in 1918; Bledsoe, Hamilton, Overton, Rhea, Sequatchie, and White in 1919; Bledsoe, Overton, Rhea, Sequatchie, and White in 1920; Bledsoe, Cumberland, Hamilton, Rhea, Roane, Sequatchie, and White in 1921; and Bledsoe, Rhea, Sequatchie, and White in 1922.

b No canvass of wagon mines for 1921.

TEXAS.

The production of coal in Texas in 1922 showed a slight increase after four years of successive decline. The output for the year was 1,106,007 tons, valued at $2,563,000. Compared with 1921 this was an increase of 133,168 tons, or 13.7 per cent, in quantity; the decline in value, $600, was negligible. The output of bituminous coal increased 54,541 tons, or 25.9 per cent; the output of lignite increased 78,627 tons, or 10.3 per cent. There was a slight decrease in the total number of employees, but the average number of days the mines were in operation rose from 139 to 185. The average production per man per day decreased 0.32 ton. In part this is explained by the relatively greater increase in output of bituminous coal, for which the daily average is lower, but there was also an actual decrease in average daily tonnage in both classes of mines.

Coal produced in Texas in 1921 and 1922.

Kind.	Net tons.				Value.		Number of employees.				Average number of days worked.
							Underground.		Surface.	Total.	
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Miners.[a]	All others.			
1921.											
Bituminous [b]	196,004	2,286	12,348	210,638	$1,241,000	$5.89	1,077	351	168	1,596	121
Lignite [c]	751,585	405	10,211	762,201	1,322,600	1.74	912	258	126	1,296	161
	947,589	2,691	22,559	972,839	2,563,600	2.64	1,989	609	294	2,892	139
1922.											
Bituminous [d]	254,053	2,284	8,842	265,179	1,342,000	5.06	1,037	252	140	1,429	190
Lignite [e]	822,542	10,273	8,013	840,828	1,221,000	1.45	957	289	166	1,412	181
	1,076,595	12,557	16,855	1,106,007	2,563,000	2.32	1,994	541	306	2,841	185

[a] Includes also loaders and shot firers.
[b] Erath, Maverick, Palo Pinto, Webb, and Wise counties.
[c] Bastrop, Henderson, Hopkins, Houston, Leon, Medina, Milam, Shelby, and Wood counties.
[d] Erath, Maverick, Palo Pinto, Webb, Wise, and Young counties.
[e] Bastrop, Bexar, Henderson, Hopkins, Houston, Leon, Milam, Nacogdoches, Shelby, Titus, and Wood counties.

Coal produced in Texas, 1918–1922, in net tons.

Kind.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Bituminous [a]	1,074,183	734,087	545,227	210,638	265,179	+54,541
Lignite [b]	1,186,952	946,569	1,069,788	762,201	840,828	+78,627
	2,261,135	1,680,656	1,615,015	972,839	1,106,007	+133,168
Total value	$5,937,997	$4,527,640	$6,062,000	$2,563,600	$2,563,000	−$600

[a] Includes Erath, Maverick, Palo Pinto, Webb, Wise, and Young counties in 1918, 1919, and 1920; Erath, Maverick, Palo Pinto, Webb, and Wise counties, in 1921; and Erath, Maverick, Palo Pinto, Webb, Wise, and Young counties in 1922.

[b] Includes Bastrop, Henderson, Hopkins, Houston, Leon, Medina, Milam, Robertson, Titus, and Wood counties in 1918; Bastrop, Fayette, Henderson, Hopkins, Houston, Leon, Medina, Milam, Nacogdoches, Titus, and Wood counties in 1919; Bastrop, Henderson, Hopkins, Houston, Lee, Leon, Medina, Milam, Nacogdoches, Shelby, and Wood counties in 1920; Bastrop, Henderson, Hopkins, Houston, Leon, Medina, Milam, Shelby, and Wood counties in 1921; and Bastrop, Bexar, Henderson, Hopkins, Houston, Leon, Milam, Nacogdoches, Shelby, Titus, and Wood counties in 1922.

UTAH.

The production of coal in Utah in 1922 was 4,992,008 tons, valued at $15,687,500. Compared with the preceding year this was an increase of 913,224 tons, or 22.4 per cent, in quantity and $2,025,500, or 14.8 per cent, in value. Every producing county except Uintah, which has the smallest output of all the counties for which separate figures are shown, made an increase. Carbon County, the leading producer of the State, increased its output 716,004 tons. Emery County, which ranks second, made a gain of 117,390 tons. The average value per ton for the State, however, declined from $3.35 to $3.14, but nevertheless this average was the third highest in the country.

Utah, like the nonunion fields of Pennsylvania, was partly shut down by the strike of 1922. From the reports furnished to the Survey by the operators it appears that at least 2,100 men, or 45 per cent of the miners employed in the State, responded to the strike call at one time or another. The average time lost per man on strike was 101 days, and the average per man employed was 45 days. (See p. 517.)

The strike, which was accompanied by bloodshed and and disorder, was no doubt one cause of the decline in average production per man per day from 6.10 tons in 1921 to 5.18 tons. But, as explained in the preceding report,[10] the average of 1921, while correctly computed, was affected by conditions that make it misleading. The averages used in the Geological Survey compilations are based on the number of tipple days. During the depression of 1921, however, certain mines continued to operate with reduced working forces. Coal might therefore have been loaded every day underground, but the tipple might have been operated only on alternate days, so that an average based upon tipple time would understate the number of days worked, and overstate the average daily production. To what extent this practice was continued in 1922 at mines working short handed because of the strike is not known.

Another cause of the high productivity per man is found in the exceptionally favorable physical conditions prevailing in the Utah mines, particularly in the thickness of the seams worked.

[10] U. S. Geol. Survey Mineral Resources, 1921, pt. 2, p. 647, 1923.

Coal produced in Utah in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
								Miners.[a]	All others.			
1921.[b]												
Carbon	3,314,553	55,832	69,203	262,053	3,701,641	$12,309,000	$3.33	2,178	929	851	3,958	156
Emery	231,525	9,284	469		241,278	870,000	3.61	161	50	44	255	95
Grand, Iron, and San Pete	69,569	2,247	2,064		73,880	296,000	4.00	60	31	13	104	83
Summit	53,014	3,618	1,539		58,171	170,000	2.92	47	27	21	95	186
Uintah		3,724	90		3,814	17,000	4.54	4	4	2	10	185
	3,668,661	[c] 74,705	73,365	262,053	[c] 4,078,784	13,662,000	3.35	2,450	1,041	931	4,422	151
1922.												
Carbon	3,984,318	38,764	94,149	300,414	4,417,645	13,877,000	3.14	2,054	1,138	996	4,188	206
Emery	349,156	9,512			358,668	1,191,000	3.32	138	117	57	312	187
Summit	69,259	7,800	1,070		78,129	199,000	2.54	45	32	17	94	224
Uintah		2,940	75		3,015	10,000	3.32	6	4	4	14	187
Other counties[d]	126,999	2,914	3,988		133,901	408,000	3.05	59	36	18	113	156
Total, excluding wagon mines	4,529,732	61,930	99,282	300,414	4,991,358	15,685,000	3.14	2,302	1,327	1,092	4,721	204
Wagon mines served by rail	650				650	2,500	3.80					
Grand total	4,530,382	61,930	99,282	300,414	4,992,008	15,687,500	3.14					

[a] Includes also loaders and shot firers.
[b] Exclusive of product of wagon mines.
[c] In addition to this amount, 11,611 tons was produced by small mines and sold to local trade. The total production of the State was therefore 4,090,395 tons, and the total sold to local trade and used by employees was 86,316 tons
[d] Grand, Iron, San Juan, and San Pete.

Coal produced in Utah, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Carbon	4,607,192	4,108,002	5,313,202	3,701,641	4,417,645	+716,004
Emery	[a] 453,172	335,054	482,828	241,278	358,668	+117,390
Grand	[a]	[b] 118,167	[b] 132,177	[b] 73,880	[b] 133,901	+60,021
Summit	67,641	54,882	65,353	58,171	78,129	+19,958
Uintah		9,929	9,228	3,814	3,015	−799
Small mines	[c] 8,820	5,289	2,411	[d]	650	[a]
Total value	5,136,825	4,631,323	6,005,199	4,078,784	4,992,008	+913,224
	$13,937,097	$12,760,613	$19,350,000	$13,662,000	$15,687,500	+$2,025,500

[a] Emery County includes Grand.
[b] Grand County includes Iron in 1919 and 1920: Iron and San Pete in 1921; and Iron, San Juan, and San Pete in 1922.
[c] Small mines include Iron County in 1918.
[d] No general canvass of wagon mines for 1921.

VIRGINIA.

Every producing county in Virginia increased its output in 1922. The production for the State as a whole was 10,491,174 tons, valued at $27,083,000. This was the second largest tonnage in the history of the State. Compared with 1921, it was an increase of 2,998,796 tons, or 40.0 per cent, in quantity and $4,135,300, or 18.0 per cent, in value. Virginia, being nonunion, was able to take full advantage of the extra demand the strike threw upon the producing districts that continued to operate. The number of days the mines were in operation averaged 198, as compared with 166 in 1921 and 262 in 1920. The productivity of labor, as measured by the daily average output per employee, however, was greater than in the two years preceding—3.93 tons, against 3.78 tons in 1921 and 3.06 tons in 1920. The average number of employees increased from 11,922 in 1921 to 13,399 in 1922, but this total was below that of 1920, which was 14,010. The increase in the average daily output was made in the face of a decrease in the proportion of machine-mined coal from 77.9 per cent in 1921 to 71.9 per cent in 1922.

Coal produced in Virginia in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				
								Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Miners.[a]	All others.	Surface.	Total.	Average number of days worked.
1921.[b]												
Chesterfield and Pulaski	24,173	13,931	14,312	----------	52,416	$203,700	$3.89	78	35	41	154	258
Dickenson	433,955	4,528	9,904	----------	448,387	1,378,000	3.07	281	229	145	655	191
Lee	677,029	7,952	2,947	----------	687,928	1,927,000	2.80	748	390	253	1,391	159
Montgomery	25,368	5,752	5,610	----------	36,730	155,000	4.22	61	24	20	105	189
Russell	1,514,803	22,481	6,578	----------	1,543,862	4,639,000	3.00	873	597	484	1,954	171
Tazewell	1,199,618	25,455	28,829	----------	1,253,902	3,989,000	3.18	836	806	278	1,920	195
Wise	2,943,232	72,630	30,770	422,521	3,469,153	10,656,000	3.07	2,874	1,975	894	5,743	153
	6,818,178	152,729	98,950	422,521	7,492,378	22,947,700	3.06	5,751	4,056	2,115	11,922	166
1922.												
Dickenson	845,363	10,375	14,496	----------	870,234	2,255,000	2.59	354	274	187	815	214
Lee	753,193	5,781	3,331	----------	762,305	2,045,000	2.68	714	324	252	1,290	152
Montgomery	32,634	5,110	4,450	----------	42,194	183,000	4.34	65	31	66	162	172
Russell	2,025,347	37,242	7,985	----------	2,070,574	5,189,000	2.51	1,023	713	553	2,289	209
Tazewell	1,508,525	25,469	29,853	----------	1,563,847	4,544,000	2.90	926	691	462	2,079	194
Wise	4,352,260	57,934	28,460	584,212	5,022,866	12,205,000	2.43	3,080	2,460	949	6,489	205
Other counties[c]	80,393	14,443	11,445	----------	106,281	435,000	4.09	128	74	73	275	132
Total, excluding wagon mines	9,597,715	156,354	100,020	584,212	10,438,301	26,856,000	2.57	6,290	4,567	2,542	13,399	198
Wagon mines served by rail	52,873	----------	----------	----------	52,873	227,000	4.29	----------	----------	----------	----------	----------
Grand total	9,650,588	156,354	100,020	584,212	10,491,174	27,083,000	2.58	----------	----------	----------	----------	----------

[a] Includes also loaders and shot firers.
[b] Exclusive of product of wagon mines
[c] Chesterfield, Pulaski, and Scott

Coal produced in Virginia, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase, 1922
Dickenson	110, 931	472, 059	614, 904	448, 387	870, 234	421, 847
Lee	888, 400	679, 017	946, 125	687, 928	762, 305	74, 377
Montgomery	[a] 131, 448	44, 081	44, 250	36, 730	42, 194	5, 464
Pulaski	([a])	[b] 65, 592	[b] 129, 899	[b] 52, 416	[b] 106, 281	53, 865
Russell	1, 998, 144	1, 801, 607	2, 122, 891	1, 543, 862	2, 070, 574	526, 712
Tazewell	1, 624, 736	1, 208, 814	1, 323, 712	1, 253, 902	1, 563, 847	309, 945
Wise	5, 514, 132	5, 049, 436	6, 062, 325	3, 469, 153	5, 022, 866	1, 553, 713
Small mines	22, 017	6, 224	134, 500	([c])	52, 873	([c])
Total value	10, 289, 808 $25, 865, 895	9, 326, 830 $23, 774, 941	11, 378, 606 $45, 446, 000	7, 492, 378 $22, 947, 700	10, 491, 174 $27, 083, 000	2, 998, 796 $4, 135, 300

[a] Montgomery County includes Pulaski and Scott in 1918.
[b] Pulaski County includes Scott in 1919 and 1920; Chesterfield in 1921; and Chesterfield and Scott in 1922.
[c] No canvass of wagon mines for 1921.

WASHINGTON.

In 1922 the production of coal in Washington increased to 2,581,165 tons, valued at $10,279,000, a gain, as compared with the preceding year of 152,443 tons, or 6.3 per cent, in quantity and $492,000, or 5 per cent, in value. The smaller percentage increase in value was due to a decrease of 5 cents in the average value per ton. Substantial increases were made in the output in King and Pierce counties, but Kittitas County lost heavily. From 25 to 50 per cent of the productive capacity of the State was shut off during the greater part of the general coal strike, but the labor situation was in some respects better than in 1921, and the average number of days the mines operated increased from 159 to 194. The average yearly output per worker, however, rose to only 575 tons, an increase of 15 tons. The daily average dropped from 3.52 to 2.96 tons. There was little change in the total number of employees, but probably considerable change in the personnel as the aftermath of the long contest between the union and the operators of commercial mines over wages in 1921.

Coal produced in Washington in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				
								Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Miners.[a]	All others.	Surface.	Total.	Average number of days worked.
1921.[b]												
King	316,597	11,904	13,045	.....	341,546	$1,053,000	$3.08	576	523	310	1,409	99
Kittitas	1,316,747	21,845	52,937	.....	1,391,529	5,766,000	4.14	1,149	402	288	1,839	194
Lewis	125,358	10,449	3,630	.....	139,437	449,000	3.22	75	56	45	176	225
Pierce	86,778	2,297	7,151	6,291	102,517	613,000	5.98	184	168	102	454	129
Skagit and Whatcom	180,500	10,951	5,372	.....	196,823	895,000	4.55	146	52	57	255	277
Thurston	248,222	2,198	6,450	.....	256,870	1,011,000	3.94	111	44	46	201	202
	2,274,202	59,644	88,585	6,291	2,428,722	9,787,000	4.03	2,241	1,245	848	4,334	159
1922.												
King	658,250	14,240	15,544	.....	688,034	2,708,000	3.93	554	445	260	1,259	241
Kittitas	991,753	21,288	39,977	.....	1,053,018	4,238,000	4.02	1,239	356	270	1,865	136
Lewis	165,186	10,550	4,581	.....	180,317	531,000	2.94	165	80	64	309	148
Pierce	246,064	3,556	13,014	41,025	303,659	1,549,000	5.10	245	220	171	636	292
Thurston and Whatcom	327,302	13,501	11,584	.....	352,387	1,236,000	3.51	231	69	112	412	201
Total, excluding wagon mines	2,388,555	63,135	84,700	41,025	2,577,415	10,262,000	3.98	2,434	1,170	877	4,481	194
Wagon mines served by rail	3,750	.....	.....	.....	3,750	17,000	4.50	.....	.....	.....	.....	.....
Grand total	2,392,305	63,135	84,700	41,025	2,581,165	10,279,000	3.98	.....	.....	.....	.....	.....

[a] Includes also loaders and shot firers

[b] Exclusive of product of wagon mines.

Coal produced in Washington, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
King	1,318,152	931,843	975,366	341,546	688,034	+346,488
Kittitas	1,733,408	1,310,386	1,837,939	1,391,529	1,053,018	−338,511
Lewis	150,247	134,490	151,686	139,437	180,317	+40,880
Pierce	600,471	355,104	413,579	102,517	303,659	+201,142
Thurston and Whatcom [a]	279,934	258,624	378,523	453,693	356,137	−97,556
Total value	4,082,212	2,990,447	3,757,093	2,428,722	2,581,165	+152,443
	$14,132,869	$10,691,222	$14,560,000	$9,787,000	$10,279,000	+$492,000

[a] Includes Skagit County 1918–1921 and small mines in 1920 and 1922; no canvass of wagon mines for 1921.

WEST VIRGINIA.

Coal production in West Virginia increased 10.6 per cent in quantity and 14.3 per cent in value in 1922. The total output for the year was 80,488,192 tons, valued at $206,162,000. The increase therefore failed to raise the production to a total approximating that of 1918 or 1920. The output on 1922 was only 1,451,639 tons greater than that of 1919, a year that was a faint forecast of 1921 in industrial depression and of 1922 in labor disturbances. The average number of days the mines were in operation during the year declined to 143—6 days less than in 1921. The increased production was due to three things—an increase in the total number of workers, with 74.2 per cent of the additional 8,164 workers employed laboring underground; an increase of 0.31 ton in the daily average output per worker; and increased running time in some of the chief producing counties of the State.

Certain fields of West Virginia are organized, but the proportion of the State's tonnage that is effectively controlled by the union is smaller than in Pennsylvania. Although 13 out of the 36 producing counties in the State showed a smaller output in 1922 than in 1921 the aggregate loss was only 4,757,150 tons, as compared with a decline of 3,381,913 tons in the semiorganized Cambria County, Pa. During the same year the other producing counties in West Virginia increased their output 12,458,346 tons. The position of the union in West Virginia at the beginning of the strike was weaker than when the strike of 1919 was called. Operators in the New River field, which includes part of Raleigh and Fayette counties, had broken relations with the union during the depression of 1921. Although this field did not wholly escape the strike in 1922, Raleigh County made a gain of 721,755 tons, and Fayette County had a loss of only 356,597 tons. Kanawha County, on the other hand, had a decrease of 1,320,198 tons. The greatest loss, 1,616,302 tons, was in Marion County, in the Fairmont district. Harrison County, in the same district, lost 381,984 tons; but Monongalia County, also in the Fairmont district, made a gain of 702,001 tons. The Pocahontas and Tug River fields, in McDowell and Mercer counties, increased their output 3,695,710 tons. The Mingo field, in Mingo and Wayne counties, made a gain of 1,449,618 tons. Logan County had an increase of 1,916,232 tons.

Two other factors should be taken into account in considering the records of production in West Virginia in 1922. The first was the marked decline in overseas export trade. Sea-borne exports of bituminous coal from the United States fell from 9,541,000 net tons in 1921 to 1,475,000 net tons in 1922. This is a trade in which West Virginia has a major share. Although the strike had some effect in bringing about the reduction, conditions abroad also played a large part during the first quarter of the year. This is borne out in part by the fact that strike-free counties such as McDowell and Mercer were able to average only 181 and 194 days, respectively, as compared with a theoretical full-time year of 308 days. The second factor was the strike of the railroad shopmen late in the summer, which had the effect of greatly slowing up transportation.

Coal produced in West Virginia in 1921 and 1922.

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
								Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Miners.[a]	All others.	Surface.	Total.	
1921.[b]												
Barbour	966,561	13,814	24,024	43	1,004,442	$2,842,200	$2.83	1,111	513	267	1,891	114
Boone	1,156,322	15,247	8,539	----------	1,180,108	3,092,000	2.62	1,330	596	373	2,299	118
Braxton	138,548	32,458	4,773	----------	175,779	433,000	2.46	228	100	59	387	91
Brooke	879,797	647,379	4,281	----------	1,531,457	4,167,000	2.72	1,526	372	254	2,152	182
Clay	593,324	19,661	7,542	----------	620,527	1,458,000	2.35	463	168	160	791	205
Fayette	5,792,650	153,488	63,656	127,002	6,136,796	19,755,000	3.22	6,171	3,461	1,690	11,322	129
Grant	150,833	847	3,954	----------	155,634	439,000	2.82	179	84	81	344	122
Greenbrier	110,557	32,818	1,546	----------	144,921	329,000	2.27	207	91	58	356	103
Hancock	1,654	1,627	75	----------	3,356	8,500	2.53	11	----------	----------	11	85
Harrison	3,623,794	130,544	13,226	----------	3,767,564	10,980,000	2.91	3,878	1,609	949	6,436	110
Kanawha	3,842,356	93,462	19,401	----------	3,955,219	11,025,000	2.79	3,993	2,020	1,433	7,446	126
Lewis	20,929	2,305	206	----------	23,440	48,000	2.05	54	25	16	95	82
Lincoln	240,581	2,356	2,706	----------	245,643	612,000	2.49	220	111	75	406	166
Logan	11,213,913	228,571	41,633	----------	11,484,117	29,482,000	2.57	6,045	4,412	2,080	12,537	168
McDowell	13,184,559	207,600	232,851	78,486	13,703,496	40,373,000	2.95	7,119	5,624	3,411	16,154	163
Marion	4,566,535	196,337	138,393	37,609	4,938,874	13,589,000	2.75	3,420	1,691	887	5,998	160
Marshall	744,290	324,114	23,905	----------	1,092,309	3,340,000	3.06	803	346	186	1,335	174
Mason	32,174	32,314	4,907	----------	69,395	204,000	2.94	109	46	34	189	116
Mercer	2,964,327	107,419	15,873	73,891	3,161,510	9,346,000	2.96	1,667	1,305	687	3,659	232
Mineral	99,808	1,337	999	----------	102,144	330,000	3.23	343	106	90	539	63
Mingo	1,766,828	99,180	27,715	----------	1,893,723	4,978,000	2.63	1,536	1,097	593	3,226	155
Monongalia	3,747,064	91,255	1,494	----------	3,839,813	9,003,000	2.34	2,566	970	621	4,157	142
Nicholas	117,944	11,614	3,642	----------	133,200	412,000	3.09	180	83	49	312	120
Ohio	1,278,466	166,108	30	----------	1,444,604	3,857,700	2.67	1,076	356	175	1,607	207
Preston	479,184	180,997	12,728	15,024	687,933	1,974,000	2.87	1,155	643	300	2,098	88
Putnam	272,003	5,046	11,281	----------	288,330	862,000	2.99	470	246	108	824	191
Raleigh	7,012,640	119,682	68,580	----------	7,200,902	22,285,000	3.09	4,422	3,008	1,471	8,901	153
Randolph	519,261	17,197	11,540	2,003	550,001	1,679,000	3.05	508	180	110	798	108
Taylor	503,549	5,147	8,153	----------	516,849	1,347,000	2.61	712	313	185	1,210	90
Tucker	844,923	11,976	38,326	6,072	901,297	3,118,000	3.46	930	309	126	1,365	162
Upshur	488,411	11,625	8,938	----------	508,974	1,285,000	2.52	433	208	137	778	123
Wayne	34,487	122	650	----------	35,259	79,100	2.24	70	34	23	127	120
Webster	11,463	9,073	----------	----------	20,536	57,000	2.78	45	10	5	60	145
Wyoming	1,218,624	7,505	224	----------	1,226,353	3,749,000	3.06	765	783	385	1,933	156
Other counties[c]	36,837	2,836	2,818	----------	42,491	123,000	2.89	56	31	20	107	103
	68,655,196	2,983,061	808,609	340,130	72,786,996	206,661,500	2.84	53,801	30,951	17,098	101,850	149

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

[c] Gilmer and Summers.

Coal produced in West Virginia in 1921 and 1922—Continued.

County.	Net tons.					Value.		Number of employees.				Average number of days worked.
								Underground.				
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total.	Total.	Average per ton.	Miners.	All others.	Surface.	Total.	
1922.												
Barbour	1,215,892	16,881	13,130	10,339	1,256,242	$3,400,000	$2.70	1,560	579	379	2,518	101
Boone	894,516	31,087	9,811		935,414	3,020,000	3.23	1,201	564	413	2,178	81
Braxton	229,793	57,074	6,769		293,636	891,000	3.03	295	122	84	501	152
Brooke	1,040,711	623,661	214		1,664,586	5,751,000	3.45	1,551	433	251	2,235	233
Clay	772,106	11,981	7,857		791,944	2,250,000	2.84	553	258	140	951	187
Fayette	5,290,985	158,198	57,433	273,583	5,780,199	18,765,000	3.25	5,894	3,257	1,697	10,848	119
Gilmer and Summers	135,475	4,083	6,385		145,943	437,000	2.99	119	60	35	214	179
Grant	92,150	755	5,350		98,255	297,000	3.03	101	41	40	182	206
Greenbrier	434,715	48,038	2,541		485,294	1,348,000	2.78	288	137	72	497	147
Hancock	9,585	2,320			11,905	34,000	2.86	24	5	4	33	78
Harrison	3,225,730	153,064	6,336	450	3,385,580	10,250,000	3.03	4,041	1,727	1,030	6,798	87
Kanawha	2,537,854	74,809	22,358		2,635,021	8,923,000	3.26	4,025	2,041	1,094	7,160	76
Lewis	59,048	20,830	330		80,208	258,000	3.22	110	38	26	174	194
Lincoln	118,616	3,037	2,077		123,730	423,000	3.41	182	77	69	328	82
Logan	13,149,036	231,504	19,809		13,400,349	37,555,000	2.80	6,149	4,613	2,303	13,065	179
McDowell	16,616,768	226,401	218,786	59,254	17,121,209	46,436,000	2.71	7,192	5,960	3,973	17,125	181
Marion	3,112,435	54,022	66,590	69,525	3,322,572	10,542,000	3.17	3,550	1,751	889	6,190	101
Marshall	935,808	415,195	20,572		1,371,575	4,567,000	3.33	960	413	185	1,558	179
Mason	26,741	23,276	1,741		51,758	152,000	2.94	122	30	22	174	103
Mercer	3,289,167	61,170	14,121	75,049	3,439,507	9,134,000	2.66	1,623	1,380	755	3,758	194
Mineral	368,232	6,742	6,732		381,706	1,238,000	3.24	566	159	139	864	131
Mingo	3,143,750	23,913	36,878		3,204,541	9,220,000	2.88	1,896	1,404	847	4,147	174
Monongalia	4,426,907	83,486	800	30,621	4,541,814	14,110,000	3.11	3,719	1,549	930	6,198	130
Nicholas	238,786	11,063	7,293		257,142	856,000	3.33	282	95	122	499	128
Ohio	1,146,187	234,499	3,412		1,384,098	4,046,000	2.92	1,329	303	200	1,832	151
Preston	1,541,695	121,028	19,431	161,910	1,844,064	5,712,000	3.10	1,691	723	461	2,875	147
Putnam	203,826	2,372	2,898		209,096	820,000	3.92	477	263	136	876	102
Raleigh	7,719,702	134,394	68,561		7,922,657	22,480,000	2.84	4,689	3,074	1,793	9,556	149
Randolph	457,149	17,236	10,768	27,130	512,283	1,602,000	3.13	488	151	100	739	131
Taylor	479,786	9,478	4,087	1,414	494,765	1,428,000	2.89	838	429	194	1,461	79
Tucker	414,436	7,702	37,505	750	460,393	1,581,000	3.43	541	202	81	824	129
Upshur	657,247	30,435	7,351		695,033	2,099,000	3.03	697	304	173	1,174	126
Wayne	170,814	2,622	623		174,059	455,000	2.62	137	69	75	281	166
Webster	26,210	5,759	30		31,999	91,000	2.85	54	9	7	70	137
Wyoming	1,713,938	10,528	560		1,725,026	4,769,000	2.76	841	809	481	2,131	162
Total, excluding wagon mines	75,895,796	2,918,643	709,139	710,025	80,233,603	234,940,000	2.93	57,785	33,029	19,200	110,014	143
Wagon mines served by rail	254,589				254,589	1,222,000	4.80					
Grand total	76,150,385	2,918,643	709,139	710,025	80,488,192	236,162,000	2.93					

Coal produced in West Virginia, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Increase or decrease, 1922.
Barbour	1,641,110	1,280,185	1,895,625	1,004,442	1,256,242	+251,800
Boone	1,349,585	1,371,552	1,613,709	1,180,108	935,414	−244,694
Braxton	350,215	381,867	348,017	175,779	293,636	+117,857
Brooke	1,378,492	1,408,085	1,711,712	1,531,457	1,664,586	+133,129
Clay	472,759	462,485	519,364	620,527	791,944	+171,417
Fayette	9,578,906	8,038,630	9,015,900	6,136,796	5,780,199	−356,597
Gilmer	69,202	79,532	122,793	[a]42,491	[a]145,943	+[a]103,452
Grant	316,808	237,985	262,539	155,634	98,255	−57,379
Greenbrier	[b]86,593	[b]132,640	[b]124,131	144,921	485,294	+340,373
Hancock	12,672	16,378	9,875	3,356	11,905	+8,549
Harrison	5,622,917	4,824,627	6,053,506	3,767,564	3,385,580	−381,984
Kanawha	6,231,431	5,068,925	6,423,044	3,955,219	2,635,021	−1,320,198
Lewis	52,472	48,938	73,151	23,440	80,208	+56,768
Lincoln	279,785	186,338	292,415	245,643	123,730	−121,913
Logan	11,268,271	9,701,320	10,627,263	11,484,117	13,400,349	+1,916,232
McDowell	18,662,621	16,780,056	16,819,148	13,703,496	17,121,209	+3,417,713
Marion	5,208,969	4,958,152	5,698,876	4,938,874	3,322,572	−1,616,302
Marshall	1,102,762	954,268	1,251,547	1,092,309	1,371,575	+279,266
Mason	241,277	114,353	215,812	69,395	51,758	−17,637
Mercer	3,174,416	2,709,405	2,692,879	3,161,510	3,439,507	+277,997
Mineral	857,913	369,470	621,203	102,144	381,706	+279,562
Mingo	3,419,583	2,908,794	1,857,471	1,893,723	3,204,541	+1,310,818
Monongalia	2,354,178	2,522,104	3,792,941	3,839,813	4,541,814	+702,001
Nicholas	183,081	206,226	293,221	133,200	257,142	+123,942
Ohio	761,274	919,639	1,392,473	1,444,604	1,384,098	−60,506
Preston	1,788,211	1,355,453	2,001,440	687,933	1,844,064	+1,156,131
Putnam	352,948	308,958	339,092	288,350	209,096	−79,234
Raleigh	7,483,829	6,896,696	7,759,703	7,200,902	7,922,657	+721,755
Randolph	1,016,572	859,425	1,029,226	550,001	512,283	−37,718
Taylor	1,348,121	974,665	1,117,092	516,849	494,765	−22,084
Tucker	1,401,670	1,075,600	1,189,011	901,297	460,393	−440,904
Upshur	466,264	571,397	727,160	508,974	695,033	+186,059
Wayne	72,239	42,666	67,025	35,259	174,059	+138,800
Webster	30,799	46,728	42,289	20,536	31,999	+11,463
Wyoming	1,236,328	1,175,435	1,447,054	1,226,353	1,725,026	+498,673
Small mines	61,566	47,576	520,000	(c)	254,589	(c)
Total value	89,935,839 $230,508,846	79,036,553 $196,551,015	89,970,707 $390,046,000	72,786,996 $206,661,500	80,488,192 $236,162,000	+7,701,196 +$29,500,500

[a] Gilmer includes Summers in 1921 and in 1922.
[b] Greenbrier includes Summers and Wetzel in 1918 and 1919; and Summers in 1920.
[c] No canvass of wagon mines for 1921.

WYOMING.

The production of coal in Wyoming in 1922 amounted to 5,971,724 tons, valued at $18,162,000, a decrease, compared with 1921, of 1,228,942 tons, or 17.1 per cent, in quantity and $5,196,500, or 22.3 per cent, in value. This was the lowest production made by the State since 1908. The general strike was responsible for the decrease, in which every county shared. The average number of days the mines were in operation dropped to 128—a decrease of 39. The average daily tonnnage per worker, however, increased 0.07 ton. In point of daily average per man Wyoming was exceeded only by Indiana and Utah. The total number of workers increased from 8,484 to 9,045, but the number of surface employees decreased from 1,464 to 1,402.

Coal produced in Wyoming in 1921 and 1922.

County.	Net tons.				Value.		Number of employees.				Average number of days worked.
	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total.	Total.	Average per ton.	Underground.		Surface.	Total.	
							Miners.[a]	All others.			
1921.[b]											
Carbon and Uinta	549,667	19,367	24,196	593,230	$2,131,000	$3.59	277	155	122	554	186
Converse, Johnson, and Weston	109,434	11,524	13,881	134,839	484,400	3.59	90	55	41	186	174
Fremont, Hot Springs, and Park	649,514	6,659	37,343	693,516	2,751,100	3.97	445	306	183	934	156
Lincoln	1,224,188	10,556	68,111	1,302,855	4,202,000	3.23	725	363	283	1,371	224
Sheridan	898,782	23,453	16,034	938,269	2,541,000	2.71	899	250	172	1,321	71
Sweetwater	3,443,099	31,936	62,322	3,537,957	11,249,000	3.18	2,353	1,102	663	4,118	178
	6,875,284	103,495	221,887	7,200,666	23,358,500	3.24	4,789	2,231	1,464	8,484	167
1922.											
Albany, Carbon, and Uinta	412,622	8,710	20,426	441,758	1,252,000	2.83	329	173	145	647	140
Fremont, Hot Springs, and Park	590,590	6,210	33,782	630,582	2,376,000	3.77	492	312	184	988	152
Johnson and Weston	51,678	18,551	9,708	79,937	253,000	3.16	80	45	29	154	137
Lincoln	976,927	10,551	50,314	1,037,792	3,132,000	3.02	777	306	266	1,349	166
Sheridan	775,635	8,322	19,100	803,057	2,492,000	3.10	956	275	205	1,436	69
Sweetwater	2,887,033	25,570	52,409	2,965,012	8,606,000	2.90	2,632	1,266	573	4,471	128
Total, excluding wagon mines	5,694,485	77,914	185,739	5,958,138	18,111,000	3.04	5,266	2,377	1,402	9,045	128
Wagon mines served by rail	13,586			13,586	51,000	3.75					
Grand total	5,708,071	77,914	185,739	5,971,724	18,162,000	3.04					

[a] Includes also loaders and shot firers.

[b] Exclusive of product of wagon mines.

Coal produced in Wyoming, 1918–1922, in net tons.

County.	1918	1919	1920	1921	1922	Decrease, 1922.
Carbon and Uinta	797,641	593,487	744,596	593,230	[a]441,758	151,472
Converse, Johnson, and Weston	367,115	[b] 260,993	264,806	134,839	[b] 79,937	54,902
Fremont, Hot Springs, and Park	789,432	732,213	888,497	693,516	630,582	62,934
Lincoln	1,912,897	1,310,949	1,473,654	1,302,855	1,037,792	265,063
Sheridan	1,917,076	1,422,145	1,912,723	938,269	803,057	135,212
Sweetwater	3,651,238	2,894,938	4,338,995	3,537,957	2,965,012	572,945
Small mines	3,289	5,013	7,000	(c)	13,586	(c)
Total value	9,438,688	7,219,738	9,630,271	7,200,666	5,971,724	1,228,942
	$22,581,019	$18,751,024	$28,741,000	$23,358,500	$18,162,000	$5,196,500

[a] Includes Albany County.
[b] Includes Crook County in 1919; no production in Converse County in 1922.
[c] No canvass of wagon mines for 1921.

COKE AND BY-PRODUCTS.

By F. G. Tryon.

INTRODUCTION.

Acknowledgments.—The preparation of this report is made possible by the hearty cooperation of the producers of coke, to whom thanks are cordially extended. Special mention should be made of the unfailing courtesy of the operators of by-product plants in supplying monthly reports of coke output. To the railroads that supplied weekly or even daily information of cars of coke loaded acknowledgments are also made. The principal credit is due to H. L. Bennit, of the United States Geological Survey, who compiled and tabulated the statistics, except those for imports and exports, which were compiled by J. A. Dorsey from records of the Bureau of Foreign and Domestic Commerce. The proof has been read by R. S. McBride, for whose advice on many technical points special thanks are due and from whose excellent reports on coke in 1919–1920 and 1921 the author has freely drawn.

Unit of measurement.—The standard unit of measurement in the coke industry in the United States is the short or net ton of 2,000 pounds. Unless otherwise specified, this is the unit employed throughout this chapter.

Definitions.—In this report the term "coke" does not include breeze or the fine coke screenings, because operators in general, especially those in the beehive industry, do not regard this fine material as properly so classified. No effort has been made to define accurately the limitation as to size between coke and breeze. Each operator has followed his own regular practice in reporting his output of fine material to the Geological Survey. It is probably safe to say, however, that coke breeze and screenings correspond closely in size to the anthracite usually classified as steam sizes—in other words, they include the material smaller than pea coal.

THE COKE-PRODUCING INDUSTRIES.

Coke is produced in the United States by a group of four industries, which are related in the sense that the product is to some extent interchangeable but which are sharply differentiated as to location, method, equipment, and organization. Besides that produced in the familiar beehive and by-product ovens, coke is obtained in the refining of petroleum, in the manufacture of coal gas, and in the refining of coal tar.

Petroleum coke may be dismissed with a few words. In refining crude oil there is often left an ultimate residue in the form of a porous, carbonaceous mass. Its properties are much like those of coke made from coal, except that it is finer in texture and lacks the strength required for metallurgical coke. The best petroleum coke is extra-

ordinarily low in ash, running less than 1 per cent—a quality which adapts it to the manufacture of carbon electrodes. Petroleum coke that can not meet the specifications for electrode manufacture or that is not in demand for that purpose is commonly used as a boiler fuel about the refinery or sold to local householders for domestic fuel. The average value of the petroleum coke produced in 1921, according to the census of manufactures, was $6.98 a ton. The production of petroleum coke in recent years, according to statistics collected by the United States Bureau of Mines, has been as follows:

Petroleum coke produced and in stock, 1917–1922, in net tons.

Year.	Production.	Stock at end of year.	Year.	Production.	Stock at end of year.
1917	539,366	7,585	1920	576,613	31,469
1918	559,663	22,605	1921	604,465	74,508
1919	603,459	21,146	1922	707,064	35,722

In the coal-gas industry, as in petroleum refining, the coke obtained is a by-product. The process of carbonization is essentially the same as that in by-product ovens, though the type of oven is different. The coals used are selected for their yield in gas rather than for their coking qualities, and the coke formed is too soft for foundry or furnace use. It is, however, well adapted to the manufacture of water gas, a fact which has led to the common association of coal-gas and water-gas plants. Thus out of 2,877,787 tons of gas-house coke produced in 1922, 51.8 per cent was used in making water gas, in heating retorts, or for boiler fuel about the plant where it was produced. The remainder, 1,387,658 tons, was sold, largely as domestic fuel, for $12,032,244.

Neither petroleum coke nor gas-house coke is adapted for metallurgical purposes, the use which consumes the great bulk of all the coke produced. Practically, therefore, the coke trade is concerned only with beehive coke and by-product coke, and to them the statistics of this report are confined. Although their product is interchangeable, there are fundamental differences between the beehive and by-product industries which must be kept in mind in examining the tables of this chapter. The competitive relations between the beehive and by-product industries have been discussed in previous reports of the Geological Survey[1] and need not be treated here. Permanently higher prices for coal and gradually expanding markets for the by-products continue to foster the development of by-product coking, and the manufacture of beehive coke assumes more and more the character of an auxiliary agency called upon to furnish only the peak requirements of the metallurgical industry in times of active business.

Between the coal-gas and the by-product coke industries the line is increasingly difficult to draw. Adaptation of the by-product oven to the needs of city gas manufacture has brought into existence a number of installations of by-product ovens as a part of existing gas utilities. Still other coke plants that are financially independent of public utilities nevertheless supply gas under contract to public-

[1] U. S. Geol. Survey Mineral Resources, 1918, pt. 2, pp. 1446-1447, 1921; idem, 1921, pt. 2, p. 374, 1923.

utility distributors. From one point of view these plants are a part of the manufactured-gas industry. But considered with reference to coke-oven design and the technique of coke manufacture, and still more significantly with reference to the supply and demand for coke, they belong to the coke industry.

In the practical operation of a by-product coke plant the fact that the gas may be sold to a public utility and distributed through the city mains is of less consequence than the fact that the coke must be marketed in competition with other coke for foundry, furnace, or household use.

For the purpose of this report all installations of by-product ovens are included as a part of the by-product coke industry, and plants manufacturing coal gas and coke-oven gas on the same premises have been asked to make separate reports for these two branches of their business. The statistics here presented will therefore differ from the tabulations of the Census Bureau, for example, which classifies such installations of coke ovens as a part of the manufactured-gas industry.

In Table 91, at the end of this report, will be found a summary of the output of manufactured gas and by-products from all sources, including both coke ovens and coal-gas, oil-gas, and water-gas plants, from which the relation of the by-product coke industry to other methods of gas manufacture may be seen.

The principal statistical facts of the coke industry in 1922 are presented in Table 1.

TABLE 1.—*Salient figures of the coke industry in 1922.*

	Beehive.	By-product.	Total.
Coke produced:			
Quantity.....net tons	8,573,467	28,550,545	37,124,012
Value	$50,036,556	$188,276,767	$238,313,323
Screenings and breeze produced:			
Quantity.....net tons	91,472	2,395,286	2,486,758
Value	$226,875	$5,123,337	$5,350,212
Coal charged into ovens:			
Quantity.....net tons	13,285,868	41,052,670	54,338,538
Value	$34,702,122	$194,015,725	$228,717,847
Average value	$2.61	$4.73	$4.21
Average yield of coke and breeze from coal.....per cent	65.1	75.3	72.9
Ovens:			
In existence Jan. 1	66,014	11,142	77,156
In existence Dec. 31	63,958	11,212	75,170
Dismantled during year	1,839	40	1,879
In course of construction Dec. 31	67	403	470
Daily coke capacity of ovens in existence Dec. 31.....net tons	No data.	119,898	No data.
Coke sold:			
Furnace.....do	6,105,003	2,934,924	9,039,927
Foundry.....do	1,164,716	1,601,733	2,766,449
Domestic and other.....do	179,670	3,865,751	4,045,421
Screenings and breeze.....do	33,946	526,157	560,103
Used by producer:			
Coke.....do	1,071,886	21,106,823	22,178,709
Screenings and breeze.....do	33,012	1,881,827	1,914,839
Average receipts per ton sold:			
Furnace coke	$5.52	$7.03	$6.01
Foundry coke	$7.15	$9.94	$8.77
Domestic and other coke	$6.04	$8.90	$8.77
Screenings and breeze	$3.32	$3.01	$3.03
By-products produced:			
Gas.....M cubic feet		442,671,114	442,671,114
Tar.....gallons		327,779,734	327,779,734
Ammonium sulphate or equivalent.....pounds		898,465,061	898,465,061
Crude light oil.....gallons		101,437,555	101,437,555
Value of by-products sold:			
Gas (surplus)		$38,625,320	$38,625,320
Tar		$6,419,743	$6,419,743
Ammonium sulphate or equivalent		$22,389,812	$22,389,812
Crude light oil and derivatives		$15,667,934	$15,667,934

REVIEW OF THE COKE TRADE IN 1922.

The year 1922 in the coke industry was one of recovery after the profound depression of 1921. The output of all coke, though half again as large as in 1921, was smaller than in any other year since 1914. At the depth of the depression the year before production of beehive coke had dropped to 6 per cent of the war-time maximum, and the by-product plants were operating at barely 35 per cent of capacity, solely for lack of orders. With the revival of the iron and steel industry demand so far increased that by August, 1922, it outstripped the ability of the industry to supply, handicapped as it then was by the coal and rail strikes, and a lack of coke became temporarily the limiting factor in the output of iron and steel. By the end of the year, however, coke production was running at the rate of 52,000,000 tons a year, a rate slightly higher than the average for 1920 and second only to the extraordinary records set during the war (fig. 31).

The year was also one of readjustment. Prices of coal and with them wages of miners in the nonunion districts had fallen in 1921 and continued to fall in the first quarter of 1922. The strike of the coal miners forced a return of wages to the higher levels that had prevailed before, and prices of coal and coke necessarily moved in the same direction. Further investment in new plants was discouraged by the unsettled conditions in the industry. More beehive ovens were abandoned, and the number of by-product ovens under construction, though greater than in 1921, was less than in any other year since 1908.

The outstanding event of the year was the strike of the coal miners and beehive coke workers, which operated at first to curtail the supply and later to augment the demand for coke. The strike affected both the beehive and the by-product branches of the industry, though in different ways.

The first to feel the strike was the beehive-coke trade. The Connellsville coke region had for years been considered immune from labor troubles. Since 1890, when the miners, at that time partly organized, had been worsted by the operators in a bloody struggle, the region had been a nonunion stronghold, in spite of the fact that it lay alongside the thoroughly organized Pittsburgh district. It weathered the strike of 1919 without the loss of a day.

In 1921, however, cuts in wages, which merchant operators particularly felt were necessary if the beehive-coke industry were to retain its fast dwindling markets, had created some dissatisfaction among the workmen of the region, and when the union miners called upon the nonunion fields to join them in their strike, several thousand men in the Connellsville region responded. The strike reached its maximum in July, and at one time or another about 80 per cent of the men in the district were out. The companies continued to operate the mines and ovens with such men as were available. The effect of the strike may be read from the curve of Figure 31. From 200,000 tons a week just before the strike broke the output of beehive coke in the country dropped to about 100,000 tons. Though greater than the average for 1921, this was hardly a fourth of what the industry had produced as late as 1920.

Prices of furnace coke during the first quarter of the year ranged from $2.75 to $3.25 a ton at the ovens, Connellsville (fig. 47).

FIGURE 31.—Weekly production of beehive coke in the United States, 1920–1922.

The news that the nonunion miners had walked out drove the price up to $6 in May, and in August it jumped to the highest figure, except for 1917 and 1920, yet recorded.

The first effect of the strike on the by-product branch of the industry was a sudden increase in demand to make good the deficiency of beehive coke. Steel companies owning both beehive and by-product ovens fired all their by-product ovens and even entered the spot market for coke. Merchant pig-iron furnaces that usually consume beehive coke turned to merchant by-product coke instead. The production of the by-product ovens rose from 57.4 per cent of capacity in March to 69.2 per cent in June (fig. 32). The mountains

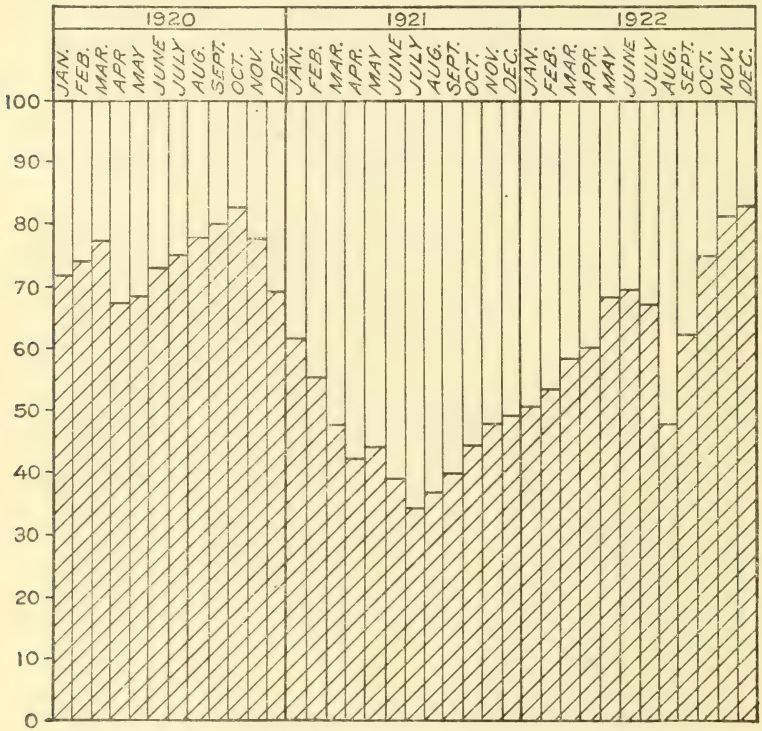


FIGURE 32.—Percentage of maximum capacity produced by by-product coke plants, 1920-1922.

of unsold coke that had accumulated at by-product plants in 1921 were now shipped away. From 987,000 tons on March 1 stocks at a group of 21 plants under contract to supply city gas had dwindled to 250,000 tons on October 1 (fig. 33).

It was not long, however, before the by-product operators found they had troubles of their own. The strike began to shut off supplies of coking coal. The Pittsburgh district was of course closed. Coal shipments from Connellsville began to fail. To eke out their dwindling reserves, by-product companies that were formerly dependent on Pennsylvania coal now turned to Kentucky and West Virginia, and for the first time railroad tariffs carried rates on Pocahontas coal into Pittsburgh.

A crisis developed in July. The flood of nonunion coal that had been pouring up from the southern fields was suddenly checked by the strike of the railway shopmen. The shortage of coke became acute, and prices jumped to $10.75 a ton, Connellsville base. Twenty-six iron furnaces went out in July. The Secretary of Commerce set up a fuel committee to distribute the coal available. Under the priorities established the coke plants that were supplying city gas could claim relief as public utilities, but the plants of the furnace interests could not. In August production of by-product coke dropped to 48.2 per cent of capacity. Thirty-six more iron furnaces went out, and the price of coke rose to $12.80 a ton. In the disordered market strange movements of coal were recorded. Southern

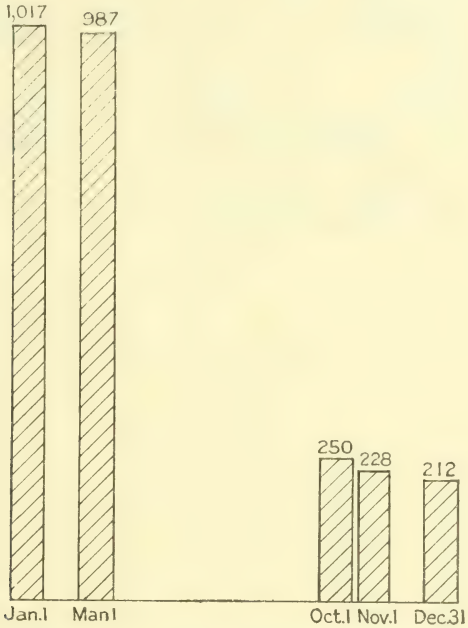


FIGURE 33.—Stocks of unsold coke at 21 by-product coke plants supplying gas for city use on five dates in 1922. Figures on columns represent thousands of tons.

coals were carried, if not to Newcastle, at least to Pittsburgh. Pocahontas coal was hauled to the Lake front and thence by vessel to Buffalo, and plants on the seaboard even sought relief in imports from Great Britain.

The coal strike was settled August 16 by the Cleveland wage agreement, and by Labor Day all the regular union districts were back at work. In the Connellsville region, however, the struggle dragged on until early in 1923, though with steadily decreasing effectiveness. Operations were resumed by the principal independent interests of the Connellsville region in October, and by December production was about equal to requirements, prices had declined to $7 (fig. 47), and by-product plants were operating at 82 per cent of capacity.

Demand continued active throughout the last third of the year, though prices were declining. The five-months' strike of the anthracite workers had created a serious shortage of household fuel. Each community was allotted only 60 per cent of its normal anthracite supply, and coke had a leading place among the substitutes. At the same time water-gas plants that had formerly used anthracite were forced to turn to coke. The situation offered a unique opportunity to extend the use of coke. Coke penetrated into many localities where before it was practically unknown, but the opportunity was largely nullified by the high retail prices at which it was often sold. The cause of this unfortunate result seems to have lain in the wholesale and retail distribution, for the average receipts from sales of domestic coke made by the producers were but little larger than in 1921 ($8.90 as against $8.22). The great bulk of the sales, as before, were made by the producing companies in the immediate vicinity of their plants.

The by-products of coke manufacture netted slightly less in 1922 than in 1921. The total receipts from all by-products amounted to $3.32 per ton of coke produced, against $3.46 in 1921 and $3.40 in 1920. Though supplies were uncertain, the prices of by-products were steady, because they are determined by the prices of competing substances outside the coke industry.

TABLE 2.—*Coke produced in beehive and by-product coke ovens in the United States, 1921 and 1922.*

[Exclusive of screenings and breeze.]

State.	Beehive.						By-product.								Total.	
	Ovens.	Coal used (net tons).	Yield of coke from coal (per cent)	Coke produced (net tons).	Value of coke at ovens.		Plants.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Value of coke at ovens.		Coke produced (net tons).	Value of coke at ovens.
					Total.	Per ton.		Built.	Under construction Dec. 31.				Total.	Per ton.		
1921.																
Alabama	6,717	223,119	59.6	132,912	$794,314	$5.98	7	1,141	30	3,476,923	69.0	2,401,127	$11,461,771	$4.77	2,534,039	$12,256,085
Colorado	1,758	123,828	65.7	81,376	(a)	(a)	1	120		417,112	68.7	286,755	(a)	(a)	368,131	(a)
Georgia	151	12,708	54.6	6,943	80,828	11.64									6,943	80,828
Illinois							7	894	5	1,952,358	67.7	1,322,178	11,383,808	8.61	1,322,178	11,383,808
Indiana							6	1,213		4,342,467	71.2	3,091,263	19,007,519	6.15	3,091,263	19,007,519
Kentucky	855	161,507	61.6	99,442	766,240	7.71	1	108		257,854	71.9	185,383	1,097,467	5.92	284,825	1,863,707
Maryland							1	300		395,526	73.9	292,439	(a)	(a)	292,439	(a)
Massachusetts							1	400		399,935	73.5	294,059	(a)	(a)	294,059	(a)
Michigan							3	390		1,103,524	70.4	777,125	7,050,191	9.07	777,125	7,050,191
Minnesota							3	220		630,173	69.2	435,866	4,337,016	9.95	435,866	4,337,016
Missouri							1	64		(b)	(b)	(b)	(b)	(b)	(b)	(b)
New Jersey							2	252		1,064,960	69.5	739,768	(a)	(a)	739,768	(a)
New Mexico	1,030	(b)	(b)	(b)	(b)	(b)									(b)	(b)
New York							5	732		1,098,014	68.0	746,916	5,451,865	7.30	746,916	5,451,865
Ohio	205	99,787	62.2	62,150	434,950	7.00	12	1,558		4,375,992	67.8	2,966,273	15,837,503	5.34	3,028,423	16,272,453
Oklahoma	300															
Pennsylvania	39,806	6,722,491	66.4	4,466,105	22,371,288	5.01	13	3,154		7,865,395	67.4	5,303,371	21,740,543	4.10	9,769,476	44,111,831
Rhode Island							1	40		(b)	(b)	(b)	(b)	(b)	(b)	(b)
Tennessee	1,848	54,328	51.5	28,005	168,794	6.03	1	24		79,911		57,723	290,675	5.04	85,728	459,469
Utah	819	(b)	(b)	(b)	(b)	(b)									(b)	(b)
Virginia	3,474	442,038	63.5	280,476	2,029,652	7.24									280,476	2,029,652
Washington	408	6,291	55.6	3,495	34,572	9.89	1	20		43,570	54.5	23,765	159,938	6.73	27,260	194,510
West Virginia	8,643	343,226	61.0	209,537	1,407,166	6.72	3	274		277,345	67.9	188,355	845,878	4.49	397,892	2,253,044
Wisconsin							2	238	50	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Combined States		286,123	58.5	167,601	1,443,672	8.62				932,052	68.4	637,214	6,107,201	9.58	804,815	7,550,873
Undistributed					634,973	7.80							12,735,271	7.89		13,370,244
	66,014	8,475,446	65.3	5,538,042	30,166,449	5.45	71	11,142	85	28,713,111	68.8	19,749,580	117,506,646	5.95	25,287,622	147,673,095

[a] Included under "Undistributed."

[b] Included under "Combined States."

TABLE 2.—*Coke produced in beehive and by-product coke ovens in the United States, 1921 and 1922*—Continued.

[Exclusive of screenings and breeze.]

State.	Beehive.						By-product.								Total.	
	Ovens.	Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Value of coke at ovens.		Plants.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Value of coke at ovens.		Coke produced (net tons).	Value of coke at ovens.
					Total.	Per ton.		Built.	Under construction Dec. 31.				Total.	Per ton.		
1922.																
Alabama	6,460	509,661	60.1	306,209	$1,735,406	$5.67	7	1,196	-------	5,115,981	68.3	3,493,656	$12,972,839	$3.71	3,799,865	$14,708,245
Colorado	1,758	183,627	65.0	119,361	821,309	6.88	1	120	-------	528,956	68.9	364,678	(a)	(a)	484,039	(a)
Georgia	151	16,178	54.6	8,832	74,807	8.47	-------	-------	-------	-------	-------	-------	-------	-------	8,832	74,807
Illinois	-------	-------	-------	-------	-------	-------	7	899	-------	2,876,987	68.9	1,982,906	18,164,549	9.16	1,982,906	18,164,549
Indiana	-------	-------	-------	-------	-------	-------	6	1,213	-------	5,509,297	72.5	3,995,505	28,978,431	7.25	3,995,505	28,978,431
Kentucky	795	53,660	56.9	30,522	216,701	7.10	1	108	-------	629,012	72.6	456,645	3,397,439	7.44	487,167	3,614,140
Maryland	-------	-------	-------	-------	-------	-------	1	300	-------	799,630	73.8	589,893	(a)	(a)	589,893	(a)
Massachusetts	-------	-------	-------	-------	-------	-------	1	400	-------	606,589	67.1	407,081	(a)	(a)	407,081	(a)
Michigan	-------	-------	-------	-------	-------	-------	3	390	-------	1,578,357	72.3	1,142,059	9,229,083	8.08	1,142,059	9,229,083
Minnesota	-------	-------	-------	-------	-------	-------	3	220	-------	688,007	67.2	462,044	4,641,871	10.05	462,044	4,641,871
Missouri	-------	-------	-------	-------	-------	-------	1	64	-------	(b)	(b)	(b)	(b)	(b)	(b)	(b)
New Jersey	-------	-------	-------	-------	-------	-------	2	252	-------	1,084,781	72.9	790,811	(a)	(a)	790,811	(a)
New Mexico	1,030	141,340	62.0	87,631	788,679	9.00	-------	-------	-------	-------	-------	-------	-------	-------	87,631	788,679
New York	-------	-------	-------	-------	-------	-------	4	692	-------	2,208,162	67.7	1,494,992	11,865,785	7.93	1,494,992	11,865,785
Ohio	205	153,034	65.0	99,468	713,186	7.17	12	1,558	-------	7,133,358	68.9	4,911,670	32,387,137	6.59	5,011,138	33,100,323
Oklahoma	300	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------
Pennsylvania	38,593	10,416,729	65.6	6,839,980	38,091,586	5.57	13	3,154	366	10,363,792	69.0	7,151,912	36,702,974	5.13	13,991,892	74,794,560
Rhode Island	-------	-------	-------	-------	-------	-------	1	40	-------	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Tennessee	1,822	174,945	49.4	86,442	618,542	7.15	1	24	-------	37,061	74.1	27,454	202,336	7.37	113,896	820,878
Utah	819	299,499	57.6	172,453	1,406,109	8.15	-------	-------	-------	-------	-------	-------	-------	-------	172,453	1,406,109
Virginia	3,372	601,528	62.9	378,656	2,291,336	6.05	-------	-------	-------	-------	-------	-------	-------	-------	378,656	2,291,336
Washington	408	40,825	63.8	26,063	241,442	9.26	1	20	-------	9,390	59.8	5,611	44,439	7.92	31,674	285,881
West Virginia	8,245	694,842	60.1	417,850	3,037,453	7.27	3	274	37	757,877	66.2	501,894	3,074,934	6.13	919,744	6,112,387
Wisconsin	-------	-------	-------	-------	-------	-------	2	288	-------	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Combined States	-------	-------	-------	-------	-------	-------	-------	-------	-------	1,125,433	68.6	771,734	7,520,701	9.75	771,734	7,520,701
Undistributed	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	19,094,249	8.86	-------	19,915,558
	63,958	13,285,868	64.5	8,573,467	50,036,556	5.84	70	11,212	403	41,052,670	69.5	28,550,545	188,276,767	6.59	37,124,012	238,313,323

[a] Included under "Undistributed."

[b] Included under "Combined States."

PRODUCTION.

GROWTH OF THE INDUSTRY.

The output of coke in the United States parallels closely the output of pig iron, which in turn is controlled by the condition of general business. Even the growing demand for coke as a domestic fuel or for the manufacture of water gas has not destroyed this parallelism; blast furnaces and other metallurgical industries remain the principal customers of the coke maker. (See fig. 34.)

The output of by-product coke has fluctuated less sharply than the manufacture of pig iron and far less sharply than the output of beehive coke, partly because the heavy capital investment in a by-product plant puts a premium on continuous production, partly because the contractual obligations of the by-product operator to furnish gas frequently demand steady operation, and partly, of course, because the number of by-product ovens has been increasing steadily, so that each year tends to show a somewhat larger output than its predecessor regardless of the state of trade. The beehive-coke industry was well established in 1880, when the statistical records of the Geological Survey begin. In that year the production was 3,338,000 tons (Table 3). By-product coke was first produced in 1893, but it was not until 1900 that the by-product ovens produced as much as 1,000,000 tons. Long after other countries had abandoned the beehive oven the tonnage of beehive coke continued to increase in the United States. It reached its maximum in 1916, when 35,464,000 tons was produced. Since then it has declined, until at present its market is more and more confined to that part of the total demand which can not be met by the by-product ovens. The first year in which the output of by-product coke exceeded that of beehive coke was 1919, when 56.9 per cent of the total production was contributed by retort ovens and 43.1 per cent by beehive ovens. In 1921 the proportions were 78.1 per cent for by-product coke and 21.9 per cent for beehive coke. Even the more active demand of 1922 did not suffice to raise the production of beehive coke above 23.3 per cent of the total, partly because the strike in the Connellsville region artificially curtailed the supply. It appears that with present plants and equipment from 65 to 80 per cent of the total supply of coke will henceforth be obtained from the by-product branch of the industry, the precise proportion depending on the condition of general business and the consequent demand for iron.

FIGURE 34.—Coke and pig iron produced in the United States, 1880–1922.

TABLE 3.—*Statistics of the manufacture of coke in the United States, 1880–1922.*

Year.	Plants.	Ovens in existence.	Coal used (net tons)	Yield of coke from coal (per cent).	Coke produced (net tons).	Value of coke at ovens.[a]	
						Total.	Per ton.
1880	186	12,372	5,237,741	63.7	3,338,300	$6,631,267	$1.99
1890	253	37,158	18,005,209	63.9	11,508,021	23,215,302	2.02
1900	396	58,484	32,113,553	63.9	20,533,348	47,443,331	2.31
1910	578	104,440	63,088,327	66.1	41,708,810	99,742,701	2.39
1911	570	103,879	53,278,248	66.7	35,551,489	84,130,849	2.37
1912	559	102,230	65,577,862	67.1	43,983,599	111,805,113	2.54
1913	551	102,650	69,239,190	66.9	46,299,530	128,922,273	2.78
1914	536	99,755	51,623,750	66.9	34,555,914	88,334,217	2.56
1915	532	99,378	61,832,898	67.2	41,581,150	105,503,868	2.54
1916	499	98,864	81,609,460	66.8	54,533,585	170,841,197	3.13
1917	482	95,896	83,752,371	66.4	55,606,828	298,243,017	5.36
1918	466	93,914	85,028,018	66.4	56,478,372	382,324,368	6.77
1919	464	92,939	65,587,918	67.4	44,180,557	258,339,740	5.85
1920	416	86,179	76,190,832	67.4	51,345,043	[b] 475,981,215	[b] 9.27
1921	374	[b] 77,156	37,188,557	68.0	25,287,622	147,673,095	5.84
1922	366	75,170	54,338,538	68.3	37,124,012	238,313,323	6.42

Year.	By-product coke.				Beehive coke.			
	Quantity.		Value.[a]		Quantity.		Value.[a]	
	Net tons.	Per cent.	Dollars.	Per cent.	Net tons.	Per cent.	Dollars.	Per cent.
1880					3,338,300	100.0	6,631,267	100.0
1885					5,106,696	100.0	7,629,118	100.0
1890					11,508,021	100.0	23,215,302	100.0
1893	12,850	0.1	(c)	(c)	9,464,730	99.9	(c)	(c)
1900	1,075,727	5.2	2,635,531	5.6	19,457,621	94.8	44,807,800	94.4
1905	3,462,348	10.7	10,851,730	15.0	28,768,781	89.3	61,624,466	85.0
1910	7,138,734	17.1	24,793,016	24.9	34,570,076	82.9	74,949,685	75.1
1911	7,847,845	22.1	27,297,897	32.4	27,703,644	77.9	56,832,952	67.6
1912	11,115,164	25.3	42,632,930	38.1	32,868,435	74.7	69,172,183	61.9
1913	12,714,700	27.5	48,637,852	37.7	33,584,830	72.5	80,284,421	62.3
1914	11,219,943	32.5	38,080,167	43.1	23,335,971	67.5	50,254,050	56.9
1915	14,072,895	33.8	48,558,325	46.0	27,508,255	66.2	56,945,543	54.0
1916	19,069,361	35.0	75,373,070	44.1	35,464,224	65.0	95,468,127	55.9
1917	22,439,280	40.4	138,643,153	46.5	33,167,548	59.6	159,599,864	53.5
1918	25,997,580	46.0	193,018,785	50.5	30,480,792	54.0	189,305,583	49.5
1919	25,137,621	56.9	160,244,768	62.0	19,042,936	43.1	98,094,972	38.0
1920	30,833,951	60.0	313,028,732	[b] 65.8	20,511,092	40.0	[b] 162,952,483	[b] 34.2
1921	19,749,580	78.1	117,506,646	79.6	5,538,042	21.9	30,166,449	20.4
1922	28,550,545	76.9	188,276,767	79.0	8,573,467	23.1	50,036,556	21.0

[a] The figures of value are not strictly comparable because the value of that part of the product consumed by the producer in associated iron furnaces but not sold has been arrived at in different ways. Prior to 1918, and also in 1919, 1921, and 1922, the value of this coke is that reported by the producer. For 1918 and 1920 it has been estimated by the Geological Survey for each State at the average value for that State of the part of the product reported sold. Value of screenings and breeze not included.

[b] Revised figures.

[c] Figures not available.

MONTHLY FLUCTUATIONS IN OUTPUT.

The parallelism between the production of coke and of pig iron becomes even clearer when the two are plotted by months, as in Figure 35. This figure consists of three diagrams drawn to a single scale. At the top are the curves of coke production, including the total for all coke, as well as the output of beehive and by-product coke separately. Below is the curve of pig-iron output. At the bottom is the index curve of trade, whose fluctuations largely explain the ups and downs of the other curves.

This index is a composite of all types of business activity—manufacturing, mining, transportation, and banking. The index is corrected for growth from year to year and for seasonal change, so that the curve here shown represents the

departure from normal. When the curve rises above the line of normal, business is active; when it falls below that line, business is dull; and the distance it reaches above or below the normal line measures roughly the intensity of the activity or the depth of the depression. * * * Beginning with the business flurry of 1911, the curve is slightly below the normal line. It rises to represent moderate

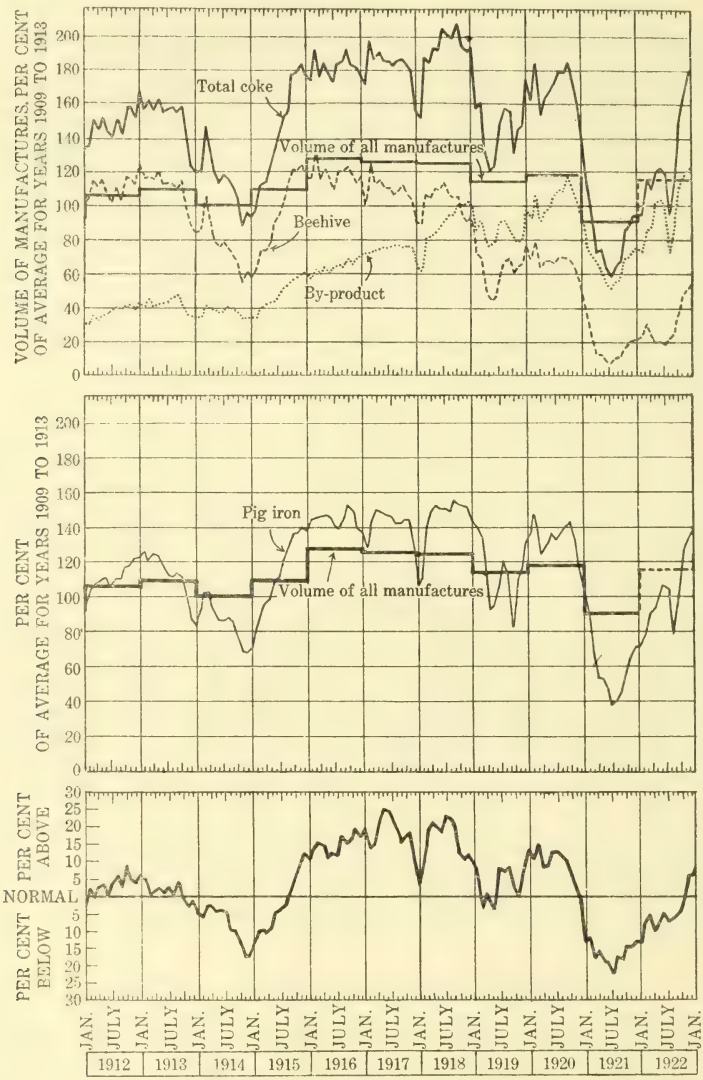

VOLUME OF MANUFACTURES, PER CENT OF AVERAGE FOR YEARS 1909 TO 1913
Total coke
Volume of all manufactures
Beehive
By-product
PER CENT OF AVERAGE FOR YEARS 1909 TO 1913
Pig iron
Volume of all manufactures
PER CENT ABOVE NORMAL
PER CENT BELOW
JAN. JULY
1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922

FIGURE 35.—Monthly fluctuations in production of coke and pig iron compared with changes in index of trade and in volume of all manufactures, 1912–1922.

The diagram at the bottom shows the index curve of trade, as computed by W. M. Persons, of the Harvard Committee on Economic Research. It shows fluctuations above and below normal after correcting for annual growth and seasonal change. The curves of coke production in the upper diagram show tons per month. Each horizontal line in the coordinate background represents 500,000 tons.

activity in 1912 and falls in the latter part of 1913 into the depression of 1914 and 1915. That depression gains momentum with the outbreak of the European war but begins to disappear in 1915 as the flood of munition orders flows in from the Allies. From that point on the curve shows the activity of the war period. The sudden but temporary drop in the winter of 1917–18 represents the traffic

congestion and coal shortage of that period, conditions which we now know were associated with the jamming of our ports and terminal facilities with goods for Europe. Other familiar landmarks in the curve are the lull following the armistice, the revival of mid-1919, the downward jog associated with the steel and coal strikes of November, 1919; the activity of 1920, and finally the great depression of 1921, from which the country did not emerge till late in 1922.[2]

The curve of pig-iron output follows the index of trade with extraordinary closeness. Pig iron has long been known as one of the most sensitive of business barometers. Its seasonal irregularity is slight, and the output is seldom affected by external causes, such as strikes. The curve here shown represents the average daily output of pig iron, which is expressed, not in tons but in terms of an index number—that is, a percentage of the daily average for the five-year period 1909 to 1913. Along with the pig-iron curve is shown the volume of manufactured goods produced during the year, as worked out by Professor E. E. Day, represented by the straight broken line. It is introduced here to supply a correction for the factor of growth from year to year, which is present in most curves representing business activity in the United States.

The volume of manufactures represents perhaps as well as any other one thing the growth trend for the country as a whole. It is independent of change in prices, and its rate of increase is midway between that of agriculture, which increases but slowly, and that of mining, which increases more rapidly. The curve for pig iron has not been corrected in any way, but some idea of how much of the upward tendency in that curve is due simply to growth, rather than business changes, may be seen from the form of the broken line, the curve for all manufactures.[3]

The curves of coke output shown in the top diagram of the series also reflect faithfully the changes of the index of trade. The heavy black line represents the total output of all coke, beehive and by-product. The lighter dash line represents beehive coke, and the dotted line by-product coke. The steady rise in the output of by-product ovens during the war period is clearly shown, and the precise point at which the by-product curve passes the beehive curve is November, 1918. All three coke curves represent the total output for the month, rather than the average daily production, and this fact introduces some small and meaningless fluctuations caused by the difference in the length of the months, fluctuations that produce a downward jog in every February and an upward jump in every March. But this error can not well be avoided, because the by-product industry works seven days a week and the beehive industry only six, therefore the daily averages for the two represent different things. Thus, though the total monthly output of by-product coke passed that of beehive coke in November, 1918, the daily rate did not cross the daily rate for beehive coke until February, 1919. (See Tables 4 and 5.)

The two curves register unmistakably the principal changes recorded by the index of trade, but the curve for beehive coke, in keeping with the function of the beehive ovens as an auxiliary source of supply, shows a more violent fluctuation than that for by-product coke. Thus both beehive and by-product coke reflect the depression of late 1914 and early 1915, but the downward jog in the curve for beehive coke is by far the greater. The same holds true for the temporary

[2] Smith, George Otis, and others, Fluctuations in mineral output, paper presented before the mining session of the American Statistical Association, Washington, D. C., December 28, 1923. Figure 35 is adapted from this paper, for which it was prepared by the author of this report.
[3] Idem, p. 4.

depression of early 1919, when both curves start down, but the dip in the beehive curve is at least three times as great as that in the by-product curve. The same tendency is observable for the depression of 1921. During 1922, however, the course of the two curves shows two sharp differences. The peak in the line of beehive coke just before April 1 and the slump thereafter mark the sympathetic strike of the nonunion workers in the Connellsville coke region. Restricted supplies of beehive coke stimulated the demand for by-product coke and resulted in a sudden increase in output, which in turn was curtailed during August and the early part of September through the shortage of coal resulting from the combined effects of the mine and railroad strikes. This drop in the curve of by-product coke, registered also in that for pig iron, offers mute but eloquent testimony to the serious reaction of a coal strike upon other business. Such a strike as that of 1922 is not merely a factor of risk and unsettlement; it may, on occasion, actually limit the volume of production in other industries.

Aside from the unusual conditions of 1922 the output of coke has been but little affected by strikes and other external factors. It responds quickly to the changing tone of general business, as interpreted by the iron market. In fact, beehive coke as the auxiliary source of fuel for iron manufacture deserves study as a supersensitive business barometer. It may well furnish the earliest indication of a change in the iron and steel market and therefore in general business.

STATISTICS OF MONTHLY PRODUCTION.

The data upon which the preceding paragraphs are based are given in detail in Tables 4, 5, and 6. The monthly statistics of by-product coke are based upon reports from the producers themselves. For the years 1917 to 1922 the reports are practically complete, and for the five earlier years, 1912 to 1916, monthly reports were obtained from the great majority of the producers and estimates were used for the few plants remaining.

The statistics of monthly production of beehive coke are estimates based upon reports of cars of coke loaded by the principal coke-carrying roads. The reports are now received weekly and are here shown readjusted to a monthly basis. As beehive coke is ordinarily not stored at the ovens in any great quantity, these shipments furnish an excellent indicator of the weekly production. The estimates also allow for shipments over Monongahela River and other waterways, concerning which current reports are furnished by the United States Engineer Corps, and for coal shipped over private railroads or consumed by associated steel works close to the ovens. Special thanks are due to the railroads for the prompt and courteous manner in which they have furnished these reports, and particularly for the trouble they have taken to go over their old records and to furnish monthly data for the pre-war years, as shown in Table 5.

The estimates thus obtained are published currently, both weekly and monthly, in the Geological Survey's weekly coal and coke report. At the end of the year the total of the current estimates does not exactly equal the actual production as reported to the Geological Survey by the operators, and a slight adjustment is therefore made in the current figures. The data in the accompanying table have been revised in this way.

TABLE 4.—*By-product coke produced in the United States, 1912–1922, by months, and average per day, in net tons.*[a]

Month.	1912		1913		1914		1915	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	778,000	25,000	1,081,000	35,000	898,000	29,000	858,000	28,000
February	778,000	27,000	1,030,000	37,000	853,000	30,000	844,000	30,000
March	878,000	28,000	1,132,000	37,000	1,032,000	33,000	971,000	31,000
April	845,000	28,000	1,030,000	34,000	987,000	33,000	1,027,000	34,000
May	900,000	29,000	1,055,000	34,000	976,000	31,000	1,084,000	35,000
June	923,000	31,000	1,068,000	36,000	920,000	31,000	1,098,000	31,000
July	967,000	31,000	1,094,000	35,000	954,000	31,000	1,196,000	39,000
August	1,000,000	32,000	1,144,000	37,000	1,010,000	33,000	1,281,000	41,000
September	978,000	33,000	1,119,000	37,000	976,000	33,000	1,337,000	45,000
October	1,023,000	33,000	1,093,000	35,000	942,000	30,000	1,421,000	46,000
November	1,056,000	35,000	992,000	33,000	830,000	28,000	1,450,000	48,000
December	989,000	32,000	877,000	28,000	842,000	27,000	1,506,000	49,000
	11,115,000	30,000	12,715,000	35,000	11,220,000	31,000	14,073,000	36,000

Month	1916		1917		1918		1919	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	1,506,000	49,000	1,788,000	58,000	1,638,000	53,000	2,445,000	79,000
February	1,449,000	50,000	1,807,000	65,000	1,534,000	55,000	2,153,000	77,000
March	1,564,000	50,000	1,813,000	58,000	2,028,000	65,000	2,285,000	74,000
April	1,506,000	50,000	1,859,000	62,000	2,002,000	67,000	2,025,000	68,000
May	1,583,000	51,000	1,879,000	61,000	2,106,000	68,000	1,906,000	61,000
June	1,526,000	51,000	1,880,000	63,000	2,080,000	69,000	1,935,000	65,000
July	1,583,000	51,000	1,882,000	61,000	2,288,000	74,000	2,244,000	72,000
August	1,621,000	52,000	1,915,000	62,000	2,366,000	76,000	2,266,000	73,000
September	1,621,000	54,000	1,919,000	64,000	2,392,000	80,000	2,168,000	72,000
October	1,716,000	55,000	1,898,000	61,000	2,547,000	82,000	1,748,000	56,000
November	1,659,000	55,000	1,900,000	63,000	2,496,000	83,000	1,971,000	66,000
December	1,735,000	56,000	1,899,000	61,000	2,521,000	81,000	1,992,000	64,000
	19,069,000	52,000	22,439,000	61,000	25,998,000	71,000	25,138,000	69,000

Month.	1920		1921		1922	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	2,426,000	78,000	2,259,000	73,000	1,886,000	61,000
February	2,343,000	81,000	1,872,000	67,000	1,800,000	64,000
March	2,646,000	85,000	1,757,000	57,000	2,137,000	69,000
April	2,267,000	75,000	1,506,000	50,000	2,206,000	74,000
May	2,400,000	77,000	1,577,000	51,000	2,544,000	82,000
June	2,487,000	83,000	1,396,000	47,000	2,594,000	86,000
July	2,658,000	86,000	1,286,000	41,000	2,501,000	81,000
August	2,742,000	88,000	1,371,000	44,000	1,822,000	59,000
September	2,744,000	91,000	1,411,000	47,000	2,249,000	75,000
October	2,915,000	94,000	1,720,000	55,000	2,812,000	91,000
November	2,679,000	89,000	1,751,000	58,000	2,931,000	98,000
December	2,527,000	82,000	1,844,000	59,000	3,069,000	99,000
	30,834,000	84,000	19,750,000	54,000	28,551,000	78,000

[a] Exclusive of screenings and breeze.

TABLE 5.—*Beehive coke produced in the United States, 1912–1922, by months, and average per working day, in net tons.*[a]

Month.	1912		1913		1914		1915	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	2,553,000	98,000	3,124,000	120,000	2,105,000	81,000	1,446,000	55,000
February	2,589,000	104,000	2,880,000	120,000	2,137,000	89,000	1,583,000	66,000
March	2,879,000	111,000	2,910,000	112,000	2,653,000	102,000	1,865,000	69,000
April	2,771,000	107,000	2,896,000	111,000	2,343,000	90,000	1,841,000	71,000
May	2,884,000	107,000	3,001,000	111,000	1,993,000	74,000	1,936,000	74,000
June	2,657,000	106,000	2,807,000	112,000	1,890,000	73,000	2,210,000	85,000
July	2,538,000	98,000	2,833,000	109,000	1,977,000	76,000	2,345,000	90,000
August	2,778,000	103,000	2,810,000	108,000	1,888,000	73,000	2,553,000	98,000
September	2,573,000	103,000	2,750,000	106,000	1,793,000	69,000	2,582,000	99,000
October	2,941,000	109,000	2,870,000	106,000	1,665,000	62,000	3,029,000	116,000
November	2,895,000	111,000	2,500,000	100,000	1,363,000	55,000	3,025,000	116,000
December	2,810,000	108,000	2,204,000	82,000	1,529,000	57,000	3,093,000	119,000
	32,868,000	105,000	33,585,000	108,000	23,336,000	75,000	27,508,000	88,000

Month.	1916		1917		1918		1919	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	2,919,000	112,000	2,923,000	108,000	2,256,000	84,000	2,366,000	88,000
February	2,887,000	115,000	2,490,000	104,000	2,225,000	93,000	1,767,000	74,000
March	3,263,000	121,000	3,139,000	116,000	2,652,000	102,000	1,714,000	66,000
April	2,875,000	115,000	2,814,000	113,000	2,591,000	100,000	1,277,000	49,000
May	3,044,000	113,000	2,861,000	106,000	2,743,000	102,000	1,101,000	41,000
June	2,918,000	112,000	2,755,000	106,000	2,713,000	109,000	1,143,000	46,000
July	2,721,000	109,000	2,754,000	110,000	2,835,000	109,000	1,457,000	56,000
August	2,999,000	111,000	2,650,000	98,000	2,650,000	98,000	1,681,000	65,000
September	3,016,000	116,000	2,727,000	109,000	2,591,000	104,000	1,736,000	67,000
October	3,079,000	118,000	2,780,000	103,000	2,621,000	97,000	1,504,000	56,000
November	2,934,000	113,000	2,677,000	103,000	2,348,000	90,000	1,629,000	65,000
December	2,809,000	108,000	2,598,000	104,000	2,256,000	90,000	1,668,000	64,000
	35,464,000	114,000	33,168,000	107,000	30,481,000	98,000	19,043,000	61,000

Month.	1920		1921		1922	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	1,946,000	72,000	1,088,000	42,000	529,000	20,000
February	1,705,000	71,000	870,000	36,000	586,000	24,000
March	1,976,000	73,000	578,000	21,000	781,000	29,000
April	1,579,000	61,000	330,000	13,000	564,000	23,000
May	1,671,000	64,000	302,000	12,000	465,000	17,000
June	1,683,000	65,000	233,000	9,000	491,000	19,000
July	1,666,000	64,000	181,000	7,000	476,000	19,000
August	1,749,000	67,000	250,000	9,000	567,000	21,000
September	1,731,000	67,000	291,000	11,000	649,000	25,000
October	1,716,000	66,000	418,000	16,000	935,000	36,000
November	1,605,000	62,000	480,000	18,000	1,214,000	47,000
December	1,484,000	57,000	517,000	20,000	1,316,000	53,000
	20,511,000	66,000	5,538,000	18,000	8,573,000	28,000

[a] Based on railroad shipments and prorated to the total production reported by operators.

TABLE 6.—*Total coke produced, by months, 1912–1922, in net tons.*

Month.	1912	1913	1914	1915	1916	1917
January	3,331,000	4,205,000	3,003,000	2,304,000	4,425,000	4,711,000
February	3,367,000	3,910,000	2,990,000	2,427,000	4,336,000	4,297,000
March	3,757,000	4,042,000	3,685,000	2,836,000	4,827,000	4,952,000
April	3,616,000	3,926,000	3,330,000	2,868,000	4,381,000	4,673,000
May	3,784,000	4,056,000	2,969,000	3,020,000	4,627,000	4,740,000
June	3,580,000	3,875,000	2,810,000	3,308,000	4,444,000	4,635,000
July	3,505,000	3,927,000	2,931,000	3,541,000	4,301,000	4,636,000
August	3,778,000	3,954,000	2,898,000	3,834,000	4,620,000	4,565,000
September	3,551,000	3,869,000	2,769,000	3,919,000	4,637,000	4,646,000
October	3,964,000	3,963,000	2,607,000	4,450,000	4,795,000	4,678,000
November	3,951,000	3,492,000	2,193,000	4,475,000	4,593,000	4,577,000
December	3,799,000	3,081,000	2,371,000	4,599,000	4,544,000	4,497,000
	43,983,000	46,300,000	34,556,000	41,581,000	54,533,000	55,607,000

Month.	1918	1919	1920	1921	1922
January	3,894,000	4,811,000	4,372,000	3,347,000	2,415,000
February	3,759,000	3,920,000	4,048,000	2,742,000	2,386,000
March	4,680,000	3,999,000	4,622,000	2,335,000	2,918,000
April	4,593,000	3,302,000	3,846,000	1,836,000	2,770,000
May	4,849,000	3,007,000	4,071,000	1,879,000	3,009,000
June	4,793,000	3,078,000	4,170,000	1,629,000	3,085,000
July	5,123,000	3,701,000	4,324,000	1,467,000	2,977,000
August	5,016,000	3,947,000	4,491,000	1,621,000	2,389,000
September	4,983,000	3,904,000	4,475,000	1,702,000	2,898,000
October	5,168,000	3,252,000	4,631,000	2,138,000	3,747,000
November	4,844,000	3,600,000	4,284,000	2,231,000	4,145,000
December	4,777,000	3,660,000	4,011,000	2,361,000	4,385,000
	56,479,000	44,181,000	51,345,000	25,288,000	37,124,000

TABLE 7.—*Beehive coke produced in the United States in 1921 and 1922, by weeks.*

[Estimated from railroad shipments.]

1921.

Week ended—	Net tons.	Week ended—	Net tons.	Week ended—	Net tons.
Jan. 1	46,000	May 7	70,000	Sept. 3	58,000
8	270,000	14	69,000	10	60,000
15	266,000	21	72,000	17	64,000
22	257,000	28	68,000	24	70,000
29	247,000	June 4	61,000	Oct. 1	78,000
Feb. 5	234,000	11	58,000	8	86,000
12	227,000	18	52,000	15	93,000
19	219,000	25	50,000	22	101,000
26	192,000	July 2	46,000	29	102,000
Mar. 5	177,000	9	35,000	Nov. 5	115,000
12	162,000	16	44,000	12	103,000
19	118,000	23	41,000	19	110,000
26	92,000	30	45,000	26	110,000
Apr. 2	81,000	Aug. 6	55,000	Dec. 3	113,000
9	78,000	13	50,000	10	112,000
16	74,000	20	57,000	17	125,000
23	73,000	27	57,000	24	116,000
30	76,000			31	103,000
					5,538,000

TABLE 7.—*Beehive coke produced in the United States in 1921 and 1922, by weeks*—Continued.

1922.

Week ended—	Net tons.	Week ended—	Net tons.	Week ended—	Net tons.
Jan. 7	116,000	May 6	101,000	Sept. 2	147,000
14	127,000	13	103,000	9	146,000
21	123,000	20	106,000	16	132,000
28	120,000	27	103,000	23	148,000
Feb. 4	130,000	June 3	104,000	30	173,000
11	137,000	10	106,000	Oct. 7	184,000
18	144,000	17	113,000	14	198,000
25	167,000	24	118,000	21	224,000
Mar. 4	153,000	July 1	122,000	28	253,000
11	164,000	8	101,000	Nov. 4	227,000
18	159,000	15	107,000	11	262,000
25	186,000	22	111,000	18	281,000
Apr. 1	204,000	29	119,000	25	307,000
8	186,000	Aug. 5	118,000	Dec. 2	318,000
15	149,000	12	119,000	9	310,000
22	100,000	19	128,000	16	319,000
29	95,000	26	124,000	23	300,000
				30	281,000
					8,573,000

Table 8 shows the monthly output of by-product coke for each State during 1920 to 1922. In the report on coke for 1918 [4] a detailed record of current output for each State was given, from which the behavior of the industry under the conditions of the war might be read. The tables here presented are significant in showing its behavior under a different set of conditions—the boom of 1920, the great depression of 1921, and the strike of 1922. Different parts of the country responded in different ways to the changing influences of this period.

[4] U. S. Geol. Survey Mineral Resources, 1918, pt. 2, pp. 1459–1473, 1921.

TABLE 8.—*Monthly production of by-product coke, by States, 1920–1922.*

State.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1920.													
Alabama	202,000	197,000	232,000	252,000	272,000	287,000	296,000	313,000	286,000	271,000	254,000	262,000	3,124,000
Colorado	22,000	36,000	41,000	41,000	48,000	46,000	49,000	49,000	45,000	45,000	45,000	50,000	517,000
Illinois	170,000	173,000	196,000	168,000	177,000	182,000	183,000	184,000	182,000	178,000	178,000	165,000	2,136,000
Indiana	403,000	363,000	409,000	256,000	336,000	358,000	364,000	344,000	373,000	441,000	449,000	458,000	4,354,000
Kentucky	39,000	37,000	40,000	39,000	42,000	40,000	42,000	40,000	38,000	39,000	35,000	36,000	467,000
Maryland	52,000	45,000	54,000	63,000	68,000	58,000	60,000	57,000	69,000	72,000	58,000	26,000	682,000
Massachusetts	40,000	31,000	42,000	45,000	44,000	38,000	41,000	41,000	49,000	44,000	38,000	35,000	488,000
Michigan	112,000	107,000	125,000	112,000	95,000	111,000	115,000	136,000	134,000	139,000	128,000	79,000	1,393,000
Minnesota	64,000	61,000	66,000	67,000	49,000	47,000	48,000	50,000	50,000	55,000	57,000	61,000	675,000
New Jersey	60,000	57,000	64,000	45,000	46,000	40,000	49,000	62,000	73,000	79,000	75,000	76,000	726,000
New York	58,000	51,000	82,000	73,000	90,000	86,000	94,000	92,000	96,000	116,000	105,000	97,000	1,040,000
Ohio	464,000	484,000	485,000	365,000	339,000	418,000	498,000	522,000	500,000	546,000	513,000	480,000	5,614,000
Pennsylvania	588,000	548,000	640,000	621,000	670,000	649,000	684,000	716,000	713,000	737,000	612,000	552,000	7,730,000
Tennessee	13,000	14,000	12,000	11,000	11,000	11,000	11,000	12,000	11,000	12,000	11,000	10,000	139,000
Washington	2,000	1,000	2,000	2,000	3,000	3,000	2,000	2,000	2,000	2,000	2,000	3,000	26,000
West Virginia	26,000	32,000	48,000	37,000	35,000	33,000	42,000	40,000	39,000	39,000	28,000	48,000	447,000
Missouri, Rhode Island, and Wisconsin	111,000	106,000	108,000	70,000	75,000	80,000	80,000	82,000	84,000	100,000	91,000	89,000	1,076,000
	2,426,000	2,343,000	2,646,000	2,267,000	2,400,000	2,487,000	2,658,000	2,742,000	2,744,000	2,915,000	2,679,000	2,527,000	30,834,000
1921.													
Alabama	245,000	223,000	212,000	192,000	174,000	173,000	144,000	173,000	175,000	230,000	229,000	231,000	2,401,000
Colorado	48,000	40,000	33,000	33,000	34,000	30,000	32,000	16,000	6,000	6,000	4,000	5,000	287,000
Illinois	157,000	130,000	123,000	100,000	124,000	85,000	76,000	80,000	96,000	105,000	114,000	132,000	1,322,000
Indiana	423,000	378,000	307,000	218,000	223,000	199,000	202,000	199,000	189,000	240,000	242,000	271,000	3,091,000
Kentucky	25,000	19,000	14,000	7,000	12,000	12,000	7,000	6,000	16,000	19,000	23,000	25,000	185,000
Maryland	26,000	25,000	27,000	27,000	28,000	24,000	20,000	18,000	19,000	24,000	26,000	28,000	292,000
Massachusetts	27,000	22,000	23,000	21,000	21,000	20,000	20,000	23,000	23,000	29,000	31,000	34,000	294,000
Michigan	56,000	55,000	59,000	48,000	61,000	64,000	66,000	67,000	66,000	80,000	72,000	83,000	777,000
Minnesota	54,000	47,000	47,000	40,000	37,000	37,000	27,000	28,000	27,000	30,000	32,000	30,000	436,000
New Jersey	69,000	60,000	64,000	63,000	64,000	61,000	64,000	59,000	58,000	59,000	58,000	61,000	740,000
New York	101,000	78,000	70,000	50,000	49,000	45,000	44,000	44,000	46,000	57,000	65,000	98,000	747,000
Ohio	394,000	249,000	229,000	211,000	242,000	195,000	171,000	183,000	198,000	291,000	300,000	303,000	2,966,000
Pennsylvania	491,000	431,000	458,000	424,000	442,000	395,000	358,000	430,000	451,000	483,000	476,000	465,000	5,304,000
Tennessee	8,000	7,000	8,000	7,000	7,000	6,000	7,000	6,000	2,000				58,000
Washington	2,000	2,000	2,000	2,000	3,000	2,000	2,000	2,000	2,000	1,000	2,000	2,000	24,000
West Virginia	52,000	36,000	15,000	3,000						22,000	32,000	29,000	189,000
Missouri, Rhode Island, and Wisconsin	81,000	70,000	66,000	60,000	56,000	48,000	46,000	37,000	37,000	44,000	45,000	47,000	637,000
	2,259,000	1,872,000	1,757,000	1,506,000	1,577,000	1,396,000	1,286,000	1,371,000	1,411,000	1,720,000	1,751,000	1,844,000	19,750,000

TABLE 8.—*Monthly production of by-product coke, by States, 1920–1922*—Continued.

State.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
1922.													
Alabama	208,000	191,000	245,000	255,000	293,000	300,000	322,000	331,000	326,000	342,000	335,000	345,000	3,493,000
Colorado	17,000	30,000	34,000	38,000	50,000	49,000	44,000	16,000	19,000	20,000	19,000	29,000	365,000
Illinois	145,000	133,000	175,000	159,000	171,000	176,000	165,000	120,000	125,000	183,000	199,000	232,000	1,983,000
Indiana	257,000	235,000	292,000	340,000	387,000	400,000	363,000	233,000	293,000	372,000	406,000	417,000	3,995,000
Kentucky	35,000	32,000	39,000	38,000	41,000	41,000	41,000	35,000	31,000	42,000	39,000	43,000	457,000
Maryland	29,000	27,000	28,000	29,000	59,000	57,000	63,000	33,000	43,000	72,000	74,000	76,000	590,000
Massachusetts	32,000	27,000	30,000	26,000	27,000	30,000	33,000	28,000	42,000	46,000	43,000	43,000	407,000
Michigan	84,000	75,000	90,000	96,000	100,000	96,000	101,000	86,000	80,000	102,000	112,000	120,000	1,142,000
Minnesota	30,000	28,000	31,000	32,000	36,000	34,000	38,000	35,000	39,000	49,000	56,000	54,000	462,000
New Jersey	56,000	55,000	59,000	61,000	63,000	63,000	65,000	67,000	70,000	72,000	78,000	82,000	791,000
New York	103,000	93,000	111,000	132,000	138,000	137,000	132,000	66,000	120,000	153,000	153,000	157,000	1,495,000
Ohio	328,000	332,000	374,000	363,000	433,000	481,000	427,000	229,000	378,000	501,000	523,000	543,000	4,912,000
Pennsylvania	479,000	470,000	538,000	544,000	635,000	626,000	592,000	466,000	598,000	720,000	734,000	750,000	7,152,000
Tennessee										4,000	11,000	12,000	27,000
Washington [a]	3,000	3,000											6,000
West Virginia	34,000	28,000	46,000	37,000	45,000	48,000	44,000	25,000	25,000	47,000	58,000	67,000	502,000
Missouri, Rhode Island, and Wisconsin	46,000	41,000	45,000	56,000	66,000	56,000	71,000	52,000	60,000	87,000	93,000	99,000	772,000
	1,886,000	1,800,000	2,137,000	2,206,000	2,544,000	2,594,000	2,501,000	1,822,000	2,249,000	2,812,000	2,931,000	3,069,000	28,551,000

[a] Partly estimated.

PRODUCTION BY FURNACE AND NONFURNACE OVENS.

In the Connellsville beehive-coke region distinction has long been made by the coke trade between the "merchant" operators and the "furnace" operators. As the name implies, the furnace interests are those affiliated with the producers of iron and steel, whose output ordinarily does not enter the open market. A similar distinction may well be made in the by-product coke industry, though here it is not always easy to classify a particular plant. Plants owned directly by steel companies and operated under the same corporate name are unmistakably "furnace" plants. Plants such as the New England Fuel & Transportation Co.'s works at Everett, Mass., are plainly comparable to the "merchant" beehive-coke plants. But there are other plants not owned by furnace operators whose output of coke, nevertheless, goes under contract to near-by iron makers and whose activities are therefore very closely intermingled with those of the iron and steel industry. In Tables 9 and 10 and Figures 36 and 37 the term "furnace plant" includes not only coke ovens

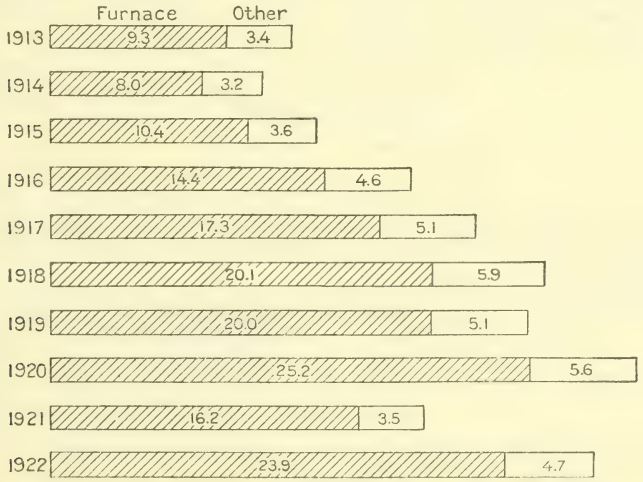


FIGURE 36.—Output of by-product coke by furnace plants and by all other plants, 1913–1922. Figures in bars represent millions of net tons produced during year.

directly owned and operated by makers of iron and steel, but also those independent plants whose entire output is sold under contract to blast furnaces. The term "other plants" is not exactly equivalent to the "merchant plants" of the beehive-coke industry. Many of the nonfurnace by-product coke plants have a relation with some other manufacturing industry, such as the production of alkali, or are tied by contract to distributors of city gas in a way that prevents them from planning their operations with regard to the coke market alone. For this reason the term "other plants" is here used in preference to "merchant plants." The class to which each by-product plant has been assigned is indicated in the list given in Table 22.

Contrary to an impression commonly prevailing, the furnace plants have been growing more rapidly both in numbers and in out-

put than the nonfurnace plants. In the ten years 1913 to 1922 the number of nonfurnace by-product plants rose from 15 to 21, but the number of furnace plants more than doubled, rising from 21 to 43 (Table 9). The growth of the furnace branch of the industry is even more striking, as measured by the record of production. The output of plants associated with city gas and manufacturing enterprises rose from 3,368,000 tons in 1913 to 4,661,000 tons in 1922, an increase of 38 per cent, but during the same period the output of the furnace plants nearly trebled, rising from 9,347,000 to 23,890,000 tons. In 1923 the furnace plants contributed 73.5 per cent of the total output of by-product coke; by 1922 their proportion had risen to 83.7 per cent. The share of the other plants declined correspondingly, from more than a fourth to barely a sixth of the whole.

The statistics also fail to bear out the contention that the nonfurnace plants, as a group, operate more steadily than the furnace plants. During 1920, for example, when the market was active, the furnace operators produced 81.8 per cent of the annual whole. Their share in the succeeding year of depression, 1921, was 82.2 per cent. Thus instead of decreasing during a depression, as might have been supposed, the percentage of the total output contributed by furnace plants actually increased.

TABLE 9.—*Number and production of by-product coke plants connected with iron furnaces, 1913–1922.*

Year.	Number of plants.		Coke produced (net tons).		Percentage of production.	
	Furnace.	Other.	Furnace.	Other.	Furnace.	Other.
1913	21	15	9,346,855	3,367,845	73.5	26.5
1914	23	14	8,029,727	3,190,216	71.6	28.4
1915	24	16	10,448,015	3,624,880	74.2	25.8
1916	29	17	14,446,576	4,622,785	75.8	24.2
1917	33	19	17,321,145	5,118,135	77.2	22.8
1918	39	21	20,124,218	5,873,362	77.4	22.6
1919	43	22	20,019,097	5,118,524	79.6	20.4
1920	45	23	25,212,745	5,621,206	81.8	18.2
1921	45	22	16,231,374	3,518,206	82.2	17.8
1922	43	21	23,889,702	4,660,843	83.7	16.3

Even when measured monthly (Table 10 and fig. 37) the relative proportions of furnace and nonfurnace coke have been remarkably constant during the last three years. In Figure 37 is plotted the average daily output of both classes of producers. The general trend of the curves is much the same, if allowance is made for the difference in their relative heights above the base line. Both show profound slumps in 1921 and gradual recovery in 1922, reaching a maximum in the middle of 1923. The curve for furnace operations reveals one sharp downward turn in August, 1922, that is not shown in like degree by the curve for other plants. This drop represents the shortage of coal during the strike of 1922, when the plants supplying gas for city use were classed as public utilities and given priority in coal supply.

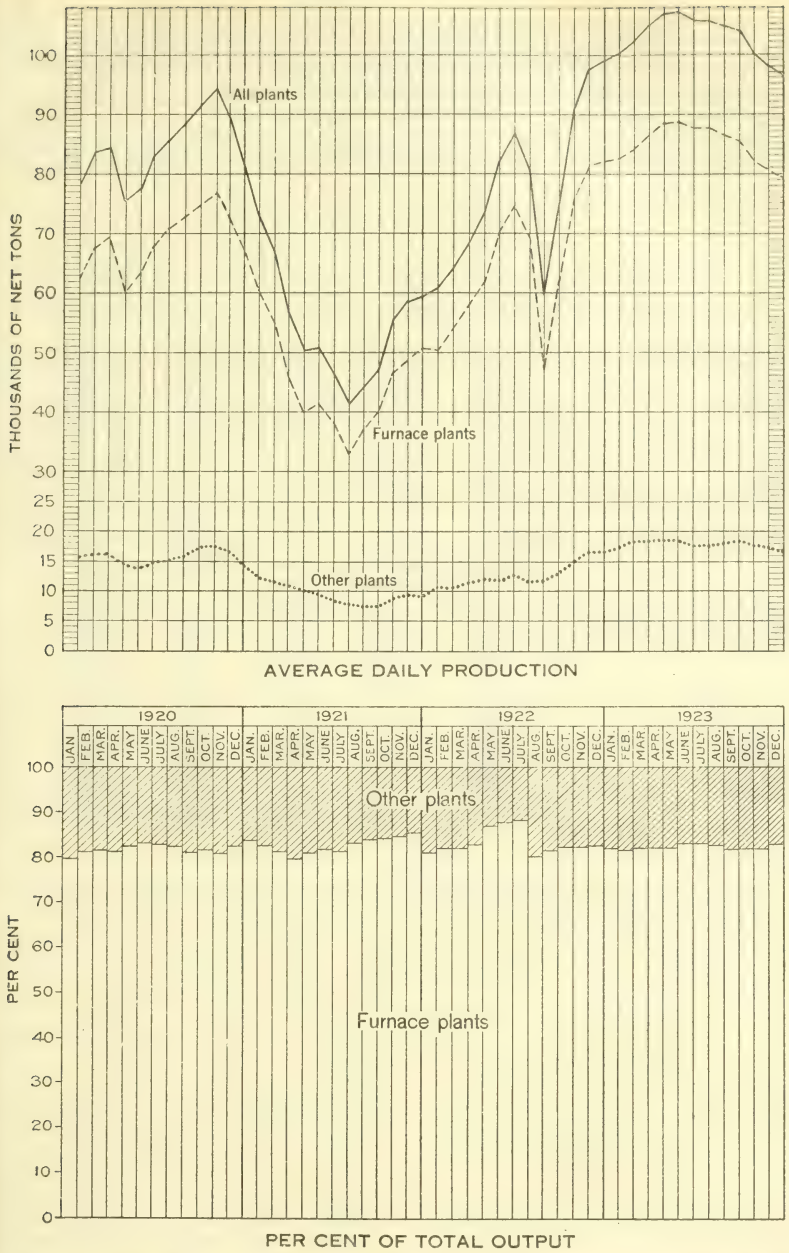


FIGURE 37.—Average daily production of coke by "furnace" and "nonfurnace" by-product coke plants and percentage that each formed of total, 1920–1923.

The relative constancy of the production from the two types of plants is brought out more clearly by the lower diagram in Figure 37, which shows the percentage of the total output contributed by each type. The furnace plants have consistently produced from 80 to 84

per cent of the total, with only one exception in the period covered. That exception was in the months of May, June, and July, 1922, when the failure of the beehive-coke supply from the Connellsville region induced maximum activity at furnace plants.

TABLE 10.—*Monthly and average daily production of by-product coke by plants associated with iron furnaces and by all other plants, 1920–1922, net tons.*

	1920		1921		1922	
	Furnace plants.	Other plants.	Furnace plants.	Other plants.	Furnace plants.	Other plants.
Monthly production:						
January	1,937,000	489,000	1,878,000	381,000	1,555,000	331,000
February	1,891,000	452,000	1,540,000	332,000	1,501,000	299,000
March	2,147,000	499,000	1,429,000	328,000	1,781,000	356,000
April	1,837,000	430,000	1,211,000	295,000	1,846,000	360,000
May	1,968,000	432,000	1,279,000	298,000	2,176,000	368,000
June	2,046,000	441,000	1,153,000	243,000	2,222,000	372,000
July	2,192,000	466,000	1,042,000	244,000	2,152,000	349,000
August	2,248,000	494,000	1,137,000	234,000	1,463,000	359,000
September	2,224,000	520,000	1,183,000	228,000	1,859,000	390,000
October	2,369,000	546,000	1,445,000	275,000	2,343,000	469,000
November	2,172,000	507,000	1,476,000	275,000	2,436,000	495,000
December	2,083,000	444,000	1,565,000	279,000	2,546,000	523,000
	25,114,000	5,720,000	16,338,000	3,412,000	23,880,000	4,671,000
Average daily production:						
January	62,500	15,800	60,600	12,300	50,200	10,700
February	67,500	16,100	55,000	11,800	53,600	10,700
March	69,200	16,100	46,100	10,600	57,400	11,500
April	61,200	14,300	40,300	9,900	61,500	12,000
May	63,500	13,900	41,200	9,600	70,200	11,900
June	68,200	14,700	38,400	8,100	74,100	12,400
July	70,700	15,000	33,600	7,800	69,400	11,300
August	72,500	15,900	36,700	7,500	47,200	11,600
September	74,100	17,300	39,400	7,600	62,000	13,000
October	76,400	17,600	46,600	8,900	75,600	15,100
November	72,400	16,900	49,200	9,200	81,200	16,500
December	67,200	14,300	50,500	9,000	82,100	16,900
Average	68,600	15,600	44,800	9,300	65,400	12,800

TABLE 11.—*Percentage of total monthly output of by-product coke that was produced by plants associated with iron furnaces and by other plants, 1920–1922.*

Month.	1920		1921		1922	
	Furnace.	Other.	Furnace.	Other.	Furnace.	Other.
January	79.8	20.2	83.1	16.9	82.4	17.6
February	80.7	19.3	82.3	17.7	83.3	16.7
March	81.1	18.9	81.3	18.7	83.3	16.7
April	81.1	18.9	80.3	19.7	83.7	16.3
May	82.0	18.0	81.1	18.9	85.5	14.5
June	82.3	17.7	82.6	17.4	85.7	14.3
July	82.5	17.5	81.2	18.8	86.0	14.0
August	82.0	18.0	83.0	17.0	80.3	19.7
September	81.1	18.9	83.8	16.2	82.7	17.3
October	81.3	18.7	84.0	16.0	83.3	16.7
November	81.1	18.9	84.2	15.8	83.1	16.9
December	82.5	17.5	84.9	15.1	82.9	17.1
	81.4	18.6	82.7	17.3	83.6	16.4

The analysis shows that the same forces that bring about curtailed production among the group dependent on the steel industry are active in the nonfurnace plants. The demand for city gas is

clearly much more constant than the demand for furnace coke, but it also is affected by the ebb and flow of general business, and the requirements of other industries play sufficient part in the market for the output of the nonfurnace group of by-product operations to introduce into their curve the same typical changes that are present in the furnace curve.

PRODUCTION BY STATES.

Increase, 1921–22.—The more active demand in 1922 called for an increase in each of the 23 States where coke is manufactured (Table 12). A decline in the output of beehive coke in Kentucky was more than offset by increased production of retort coke. Smaller supplies of retort coke in Tennessee and Washington were overcome by

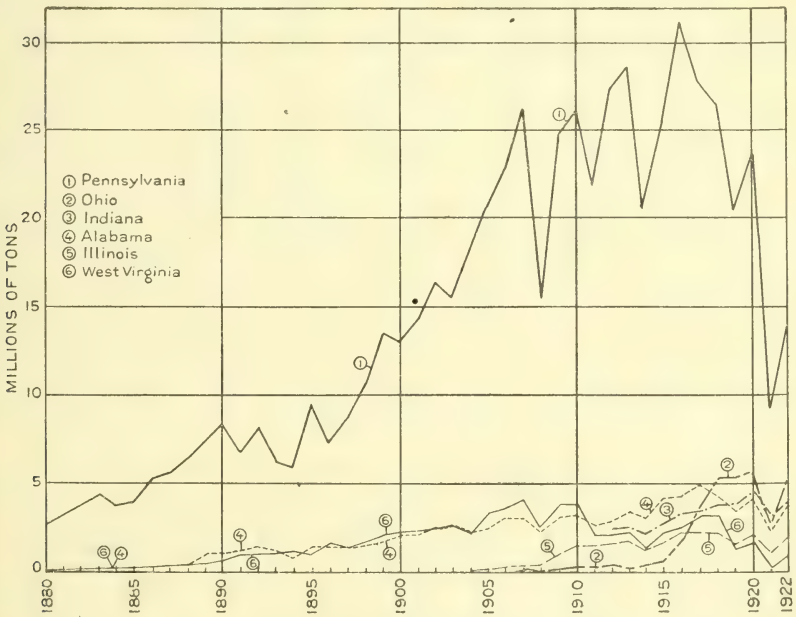


FIGURE 38.—Coke produced in six leading States, 1880–1922.

increased activity at the beehive plants in those States. The average percentage of increase in output as a whole was 47. The smallest increase was 6 per cent, in Minnesota, and the largest was 131 per cent, in West Virginia.

Geographic shifts in production.—From the historical tables (12, 13, and 14) and the curves of output in Figure 38, two facts stand out. One is the continued preeminence of Pennsylvania among the coke-producing States. Pennsylvania remains the largest producer both of beehive and of by-product coke. Even in 1922, when the Connellsville region was largely shut down by the strike, the output of Pennsylvania was nearly three times that of its nearest competitor, Ohio. In fact, the State still produces as much as any other five States.

No less significant, though less apparent, is the migration of the industry away from the fields that produce coking coal, to which it was formerly confined, and toward the centers of consumption to the north and west, a migration associated with the replacement of beehive with by-product coke. Pennsylvania reached its maximum output in 1913, and the increased supplies of coke during the war came, not from Pennsylvania, but from Alabama and West Virginia and still more from Illinois, Indiana, and Ohio. Whereas in 1880 Pennsylvania contributed 85 per cent of the total output of the country, by 1900 its share had dropped to 65 per cent. For the next 15 years the proportion produced by Pennsylvania was roughly constant, amounting, in 1915, to 61.6 per cent, but during the war it again declined rapidly, reaching 47.3 per cent in 1918, and during the depression of 1921 it dropped to 38.6 per cent.

The cause of this shift in centers of production was the rapid development of by-product coking. Even before the European war broke out the competition of by-product coke had forced the closing down of beehive-coke plants, in districts remote from the mines, and beehive ovens formerly operated in Illinois, Indiana, Montana, Kansas, and Wisconsin had yielded probably their last supplies of coke. The war greatly accelerated the building of by-product ovens. For a time the demand of the munitions industry for coke was such as to keep in active production the beehive plants of the Appalachian and Rocky Mountain coal fields, but the greater part of the increased supplies of coke came from the by-product industry. The full extent in the shift in centers of production was not revealed until the depression of 1921. In that year the States from which coking coal is obtained produced but 57 per cent of the total output of all coke, as against 97 per cent in 1900. Conversely, the States producing little or no coking coal and depending on outside supplies contributed 43 per cent of the total supply in 1921, as against 3 per cent in 1900.

The nature of the shift in production is well suggested by Figure 38. In 1910 West Virginia was second among the coke-producing States and Ohio was fourteenth. In 1921 Ohio had risen to second place and West Virginia had dropped to eighth place (Table 14).

Summary.—The following tables give by States the principal statistics of the production of coke in 1921 and 1922. Screenings and breeze are not included here but are discussed on pages 726–728.

TABLE 12.—*Coke produced in the United States, 1918, 1920, 1921, and 1922, in net tons.*

State.	1918	1920	1921	1922	Increase, 1922.			
					Quantity.	Percentage.		
						Total.	Beehive.	By-product.
Alabama	4,352,172	4,013,891	2,534,039	3,799,865	1,265,826	50	130	45
Colorado	989,447	789,499	368,131	484,039	115,908	31	47	27
Georgia	22,048	16,523	6,943	8,832	1,889	27	27	----
Illinois	2,285,610	2,136,793	1,322,178	1,982,906	660,728	50	----	50
Indiana	3,898,215	4,553,697	3,091,263	3,995,505	904,242	29	----	29
Kentucky	818,785	739,577	284,825	487,167	202,342	71	[a] 69	146
Maryland	474,368	682,132	292,439	589,893	297,454	102	----	102
Massachusetts	556,397	488,089	294,059	407,081	113,022	38	----	38
Michigan	(b)	1,393,445	777,125	1,142,059	364,934	47	----	47
Minnesota	784,065	674,801	435,866	462,044	26,178	6	----	6
Missouri	(b)	(b)	(b)	(b)	(b)	(b)	----	(b)
New Jersey	682,148	725,571	739,768	790,811	51,043	7	----	7
New Mexico	597,072	(b)	(b)	87,631	(b)	(b)	(b)	----
New York	1,069,587	1,040,192	746,916	1,494,992	748,076	100	----	100
Ohio	5,365,243	5,701,810	3,028,423	5,011,138	1,982,715	65	60	66
Oklahoma	(b)	(b)	----	----	----	----	----	----
Pennsylvania	26,723,645	23,638,739	9,769,476	13,991,892	4,222,416	43	53	35
Rhode Island	----	(b)	(b)	(b)	(b)	(b)	----	(b)
Tennessee	427,106	301,708	85,728	113,896	28,168	33	209	[a] 52
Utah	(b)	(b)	(b)	172,453	(b)	(b)	(b)	----
Virginia	1,234,256	1,027,788	280,476	378,656	98,180	35	35	----
Washington	123,788	59,395	27,260	31,674	4,414	16	646	[a] 76
West Virginia	3,320,006	1,828,336	397,892	919,744	521,852	131	99	166
Wisconsin	(b)	(b)	(b)	(b)	(b)	(b)	----	(b)
Combined States	2,754,414	1,533,057	804,815	771,734	227,003	28	55	21
	56,478,372	51,345,043	25,287,622	37,124,012	11,836,390	47	55	45

[a] Decrease.
[b] Included under "Combined States."

TABLE 13.—*By-product and beehive coke produced in the United States, 1915, 1918, 1920, 1921, and 1922, in net tons.*

State.	1915	1918	1920	1921	1922
By-product.					
Alabama	2,070,334	2,634,451	3,123,890	2,401,127	3,493,656
Colorado	----	230,663	516,673	286,755	364,678
Illinois	1,686,998	2,285,610	2,136,793	1,322,178	1,982,906
Indiana	2,768,099	3,898,215	4,553,697	3,091,263	3,995,505
Kentucky	241,581	517,749	466,985	185,383	456,645
Maryland	313,283	474,368	682,132	292,439	589,893
Massachusetts	504,438	556,397	488,089	294,059	407,081
Michigan	(a)	(a)	1,393,445	777,125	1,142,059
Minnesota	127,847	784,065	674,801	435,866	462,044
Missouri	(a)	(a)	(a)	(a)	(a)
New Jersey	269,448	682,148	725,571	739,768	790,811
New York	684,461	1,069,587	1,040,192	746,916	1,494,992
Ohio	665,557	5,226,334	5,614,877	2,966,273	4,911,670
Pennsylvania	3,992,295	4,586,981	7,730,256	5,303,371	7,151,912
Rhode Island	----	----	(a)	(a)	(a)
Tennessee	23,268	124,469	139,121	57,723	27,454
Washington	(a)	30,129	26,284	23,765	5,611
West Virginia	141,211	603,393	447,392	188,355	501,894
Wisconsin	(a)	(a)	(a)	(a)	(a)
Combined States	1,484,075	2,293,021	1,073,753	637,214	771,734
	14,072,895	25,997,580	30,833,951	19,749,580	28,550,545

[a] Included under "Combined States."

TABLE 13.—*By-product and beehive coke produced in the United States, 1915, 1918, 1920, 1921, and 1922, in net tons*—Continued.

State.	1915	1918	1920	1921	1922
Beehive.					
Alabama	1,001,477	1,717,721	890,001	132,912	306,209
Colorado	670,938	758,784	272,826	81,376	119,361
Georgia	20,039	22,048	16,523	6,943	8,832
Kansas					
Kentucky	284,516	301,036	272,592	99,442	30,522
New Mexico	389,411	597,072	(a)	(a)	87,631
Ohio	19,101	138,909	86,933	62,150	99,468
Oklahoma		(a)			
Pennsylvania	22,530,567	22,136,664	15,908,483	4,466,105	6,839,980
Tennessee	233,705	302,637	162,587	28,005	86,442
Utah	(a)	(a)	(a)	(a)	172,453
Virginia	629,807	1,234,256	1,027,788	280,476	378,656
Washington	(a)	93,659	33,111	3,495	26,063
West Virginia	1,250,235	2,716,613	1,380,944	209,537	417,850
Combined States	478,459	461,393	459,304	167,601	
	27,508,255	30,480,792	20,511,092	5,538,042	8,573,467

[a] Included under "Combined States."

TABLE 14.—*Rank of the States in the production of coke, 1918–1922.*

State.	1918		1919		1920		1921		1922	
	All coke.	By-product coke.	All coke.	By-product coke.	All coke.	By-product coke.	All coke.	By-product coke.	All coke.	By-product coke.
Pennsylvania	1	2	1	1	1	1	1	1	1	1
Ohio	2	1	2	2	2	2	3	3	2	2
Indiana	4	3	3	3	3	3	2	2	3	3
Alabama	3	4	4	4	4	4	4	4	4	4
Illinois	6	5	5	5	5	5	5	5	5	5
New York	8	6	11	9	8	7	7	7	6	6
Michigan	9	7	9	7	7	6	6	6	7	7
West Virginia	5	11	6	14	6	15	10	15	8	10
New Jersey	14	10	10	8	12	8	8	8	9	8
Maryland	17	14	16	15	14	10	14	12	10	9
Kentucky	12	13	12	12	11	14	15	16	11	12
Colorado	11	16	13	11	10	12	11	13	12	15
Minnesota	13	9	14	10	15	11	9	9	13	11
Massachusetts	16	12	15	13	16	13	13	11	14	14
Virginia	7		7		9		16		15	
Missouri	20	15	19	16	19	16	17	14	16	16
Utah	19		20		20		18		17	
Rhode Island			21	17	21	18	19	17	18	17
Tennessee	18	17	17	18	17	17	20	18	19	18
New Mexico	15		18		18		22		20	
Washington	21	18	22	19	22	19	21	19	21	19
Georgia	23		23		23		23		22	
Oklahoma	22		24						23	

COKE IN PENNSYLVANIA.

Though forced to yield first place to Ohio as producer of by-product coke in 1918, Pennsylvania quickly recovered first rank the next year and has maintained it since. In fact, the statistics of coke production, taken by themselves, fail to do justice to the position of the State in the coke industry, for in addition to her coke she supplies much of the raw coal required by the by-product ovens in adjoining States.

The growth of by-product coking in Pennsylvania entered upon a new phase when it became profitable to construct by-product plants in the heart of the Pittsburgh district. High prices of the

benzols and ammonia, waning supplies of natural gas, and the consequent premium on coke-oven gas, and the need for maximum economy in the utilization of coking coal itself combined to promote the erection of by-product ovens during the war. Two smaller plants had been built in the vicinity of Pittsburgh in the nineties, but thereafter activity in the construction of by-product ovens had been greatest at points remote from the mines. The war saw the construction of the great Clairton plant of the Carnegie Steel Co., the largest by-product works in the world; the Pittsburgh plant of the Jones & Laughlin Steel Co.; and the Midland plant of the Pittsburgh Crucible Steel Co.

No new by-product ovens were completed in Pennsylvania during 1922, but at the end of the year 366 ovens were being built at the Clairton plant.

In spite of the strike, all the districts producing beehive coke made a larger output in 1922 than in 1921.

TABLE 15.—*Beehive and by-product coke produced in Pennsylvania in 1922, by districts.*

District.	Plants.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Value of coke at ovens.	
		Built.	Under construction.				Total.	Per ton.
Beehive:								
Allegheny Mountain and Allegheny Valley	7	678	.....	177,868	60.9	108,264	$938,114	$8.66
Connellsville	68	16,334	.....	5,900,104	66.3	3,913,229	20,423,667	5.22
Lower Connellsville	59	13,160	.....	2,575,613	67.5	1,740,414	9,546,128	5.48
Pittsburgh	8	2,977	.....	371,561	57.8	214,925	1,433,880	6.67
Upper Connellsville	11	1,549	.....	417,120	59.2	246,806	1,835,684	7.44
Other districts [a]	14	3,895	67	974,463	63.2	616,342	3,914,113	6.35
	167	38,593	67	10,416,729	65.6	6,839,980	38,091,586	5.57
By-product:								
Eastern Pennsylvania [b]	5	844	.....	2,245,341	71.3	1,600,504	11,533,016	7.21
Western Pennsylvania [c]	8	2,310	366	8,118,451	68.4	5,551,408	25,169,958	4.53
	13	3,154	366	10,363,792	69.0	7,151,912	36,702,974	5.13
Grand total	180	41,747	433	20,780,521	67.3	13,991,892	74,794,560	5.35

[a] Includes Bedford, Clearfield, Huntingdon, Jefferson, and parts of Indiana and Westmoreland counties.
[b] Includes plants at Bethlehem, Steelton, Lebanon, Chester, and Swedeland.
[c] Includes plants at Glassport, Franklin, Rosedale, Clairton, Farrell, Dunbar, Pittsburgh, and Midland.

The Courier, of Connellsville, Pa., has for many years published weekly and monthly statistics of production and movement from the Connellsville coke region, and the following table of shipments, by months, is abstracted from that paper. In earlier volumes of Mineral Resources the statistics for preceding years will be found. They furnish a satisfactory index to the current production of beehive coke, by months. This statistical record deserves attention from the students on business forecasting as one of the few series of monthly data of production in the United States that can be carried back over long periods.

TABLE 16.—*Coke shipped from the Connellsville and Lower Connellsville districts, Pa., 1915, 1918, 1920, 1921, and 1922, in net tons.*[a]

Month.	1915	1918	1920	1921	1922
January	940,781	1,021,055	1,082,289	735,897	377,003
February	1,045,739	991,871	967,122	552,568	397,537
March	1,258,559	1,436,821	1,110,550	361,646	584,497
April	1,268,292	1,459,248	799,578	198,966	377,433
May	1,310,639	1,532,634	749,537	186,256	247,145
June	1,486,845	1,438,700	796,698	130,324	276,304
July	1,618,199	1,578,130	778,345	92,880	283,472
August	1,657,203	1,492,065	909,270	158,250	371,499
September	1,683,414	1,423,236	879,297	188,664	451,240
October	1,851,938	1,410,403	921,753	257,499	628,333
November	1,873,405	1,136,355	889,173	303,532	799,087
December	1,926,202	1,160,072	854,615	405,935	872,950
	17,921,216	16,080,590	10,738,227	3,572,417	5,666,500

[a] Statistics from the Weekly Courier, Connellsville, Pa.

COKE IN WEST VIRGINIA.

West Virginia is rich in coking coal. Beehive coke has long been produced in both the northern and southern portions of the State, and in both the low-volatile and high-volatile coal districts. The yield of merchantable coke per ton of coal charged in beehive practice in this State is somewhat smaller than in Pennsylvania. Reacting from a period of temporary activity during the war, the production of beehive coke in West Virginia has declined. Even the shortage of coke that followed the coal strike of 1922 resulted more in speeding up the shipments of West Virginia raw coal suitable for by-product use in other States than it did in the production of beehive coke in the State itself. In every one of the six producing districts shown in Table 17 the output increased as compared with 1921, but it was far short of the record set in 1918.

West Virginia also produces by-product coke, in the output of which it ranked tenth in 1922. The three plants are all in the northern part of the State. Two of them are tributary to the Wheeling-Pittsburgh district; the other, at Fairmont, sells its coke for domestic and merchant industrial use.

TABLE 17.—*Beehive and by-product coke produced in West Virginia in 1922, by districts.*

District.	Plants.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Value of coke at ovens.	
		Built.	Under construction.				Total.	Per ton.
Beehive:								
Flat Top	12	1,944	-------	134,302	61.0	81,929	$469,360	$5.73
Tug River	1	2,137	-------					
Kanawha	4	583	-------	95,034	60.3	57,315	426,787	7.45
New River	12	1,198	-------	163,667	58.8	96,181	874,976	9.10
Upper Monongahela and Panhandle	21	1,776	-------	263,620	59.2	156,094	1,063,554	6.81
Upper Potomac and Tygarts Valley	6	607	-------	38,219	68.9	26,331	202,776	7.70
	56	8,245	-------	694,842	60.1	417,850	3,037,453	7.27
By-product: Fairmont, Benwood, and Follansbee	3	[a] 274	[a] 37	757,877	66.2	501,894	3,074,934	6.13
Grand total	59	8,519	37	1,452,719	63.3	919,744	6,112,387	6.65

[a] Koppers ovens.

COKE IN OHIO.

Ohio has for many years been a small but regular producer of beehive coke. In 1922 two beehive plants were in operation, and they produced 99,468 tons.

The State's chief claim to note in the coke industry is as a producer of by-product coke, in which its rise since 1914 has been extremely rapid. (See fig. 38.) In 1914 there were two by-product plants in operation in the State, with a total output of 453,000 tons. The boom in the by-product industry brought about by the war prices for toluol and benzol resulted in the construction of nine other plants. By 1920 the output had increased to 5,615,000 tons. Though production dropped to 3,000,000 tons during the depression of 1921, it rose again to almost 5,000,000 tons in 1922.

TABLE 18.—*Beehive and by-product coke produced in Ohio in 1922, by districts.*

District.	Plants.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Value of coke at ovens.	
		Built.	Under construction.				Total.	Per ton.
Beehive	2	205	.....	153,034	65.0	99,468	$713,186	$7.17
By-product:								
Canton and Cleveland	4	531	.....	2,276,725	71.2	1,621,711	12,795,244	7.89
Youngstown	3	533	.....	2,536,828	65.8	1,669,522	9,797,132	5.87
Other districts [a]	5	494	.....	2,319,805	69.8	1,620,437	9,794,761	6.04
	12	1,558	.....	7,133,358	68.9	4,911,670	32,387,137	6.59
Grand total	14	1,763	.....	7,286,392	68.8	5,011,138	33,100,323	6.61

[a] Includes plants at Dover, Ironton, Lorain, Portsmouth, and Toledo.

COKE OVENS.

INCREASE IN NUMBER OF BY-PRODUCT OVENS.

At the end of 1922 there were in the United States 11,212 by-product coke ovens of all types, and in addition 403 ovens were under construction. The number of ovens, by States, is given in Tables 19 and 21 and a list of the by-product plants with the types of ovens installed at each in Tables 22–24.

Since the first by-product plant was put in operation, at Solvay, N. Y., in 1893, there have been three periods during which construction of new retort ovens was particularly active in the United States. They are shown by Figure 40, in which the broken line represents the number of ovens under construction at the end of each year.

In the pioneer days of the industry, from 1893 to 1900, most of the plants constructed were close to the principal centers of steel manufacture and the fields of coking coal. To this period belong the first developments at Dunbar, Glassport, and Johnstown, Pa.; Benwood, W. Va.; and Ensley, Ala. But the pioneer period was not without construction of ovens remote from the mines. Besides the plant at Solvay, N. Y., to which belongs the honor of the first production on this continent, the plant of the New England Fuel &

Transportation Co. at Everett, just outside of Boston, was built at this time.

Of the two types of locations, that remote from the mines demonstrated greater advantages in competition with beehive coke, and most of the new plants built during the first period of active construction—from 1900 to 1905—lay far from the Connellsville, West Virginia, and Alabama fields (fig. 39). To this period belongs the construction of plants at Detroit and Wyandotte, Mich.; at Hamilton, near Cincinnati, Ohio; at Milwaukee, Wis.; at Chicago, Ill.; at Duluth, Minn.; at Buffalo and Geneva, N. Y.; and, most notable, a group of plants in eastern Pennsylvania, Maryland, and New Jersey, including Lebanon, Chester, Baltimore, and Camden. Only one plant was built in the region close to the mines during this period, namely, the Sharon or Farrell plant, in the Shenango Valley, completed in 1903, although another at Tuscaloosa came into production in 1906, after the period was over and before the next began. It was a period when a satisfactory local market for the ammonia and the gas, at that time the only by-products of much value, was particularly necessary to justify construction of a by-product plant, and the abundant supplies of natural gas, especially in the Pittsburgh district, limited the price at which by-product gas could be sold to a figure that hardly justified its recovery.

The second period of rapid construction began as the country emerged from the panic of 1907–8, and it lasted until the depression of 1913–14. In this as in the first period most of the plants built were at points remote from the mines, but they were constructed primarily to furnish coke to blast furnaces. To this period belong plants at Bethlehem, Pa.; Ashland, Ky.; Gary and Indiana Harbor, Ind.; Joliet and Waukegan, Ill.; Mayville, Wis.; Seattle, Wash.; and Toledo and Cleveland, Ohio. The only plants constructed near the mines of coking coal during this period were two in Alabama, where absence of natural gas put a premium on the by-product gas of the ovens. These plants were at Fairfield and Woodward, Ala.

The third period of active construction began early in 1915, when the European war created an intensely active demand for a new group of by-products. Before 1915 only one company in the United States recovered benzol and toluol from its gas, although that company operated a number of plants. As soon as the Allies' orders for munitions began to flow into the country, the price of benzol, the base from which picric acid is made, shot up from 25 cents a gallon to 50 and later to 70 and 80 cents. The price of toluol, which had sold for about 28 cents in 1913, rose even higher, because of the favor in which T. N. T. (trinitrotoluol) was held as a high explosive. In June, 1914, toluol sold for 30 cents a gallon. In April, it jumped to $2.50 a gallon, and the peak price reached late in 1915 and early in 1916 was $4.50 or even $6 a gallon. Simultaneously with the demand for these by-products in the manufacture of explosives came an acute shortage of dyes as the British blockade tightened around Germany. Naphthalene, a troublesome impurity before the war, came into its own as a source of revenue. From 2 to 3 cents a pound before the war the price of naphthalene rose to 16 cents late in 1915. Ammonia also rose sharply in price. The profits to be made from the by-products led every plant in existence to install benzol-recovery apparatus and further stimulated the con-

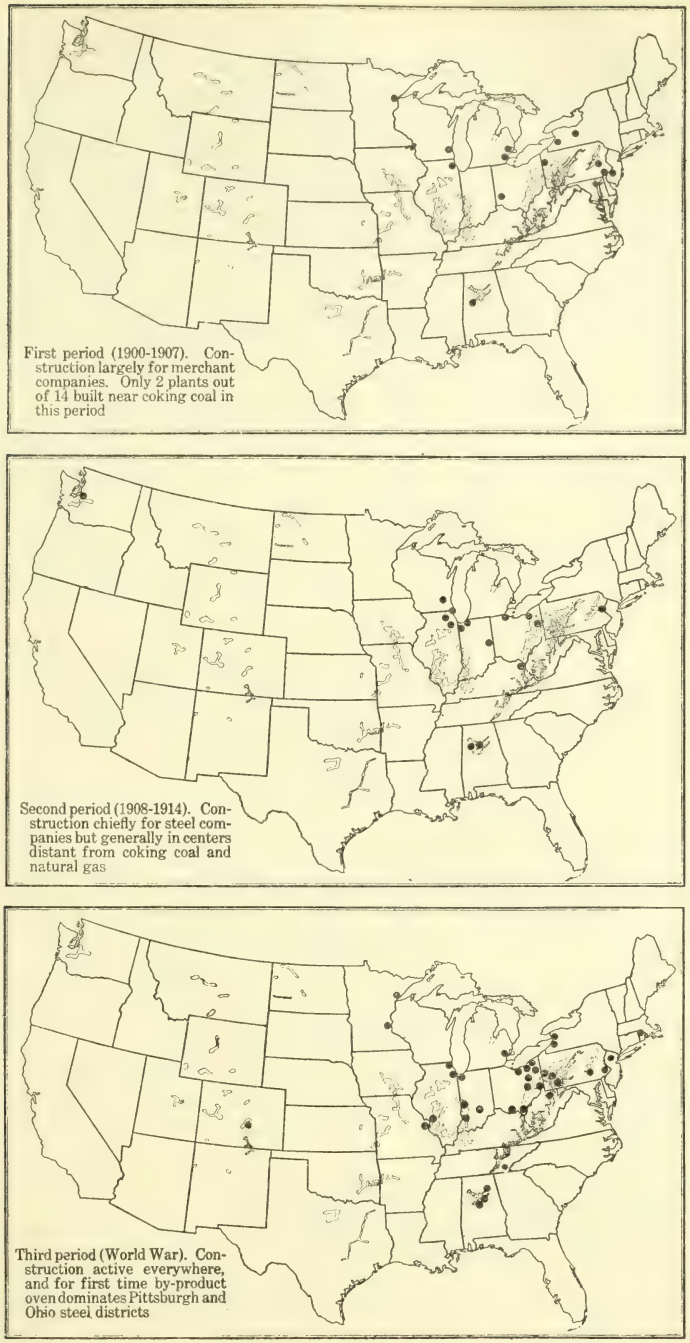

First period (1900-1907). Construction largely for merchant companies. Only 2 plants out of 14 built near coking coal in this period
Second period (1908-1914). Construction chiefly for steel companies but generally in centers distant from coking coal and natural gas
Third period (World War). Construction active everywhere, and for first time by-product oven dominates Pittsburgh and Ohio steel districts

FIGURE 39.—Location of by-product coke plants completed during the three periods of most active construction.

Fields producing good coking coal are shown by stippling; other coal fields in outline. Each dot represents a coke plant completed during the period.

struction of many new plants. This time the development was most active in the districts nearer to the mines that had hitherto been dominated by beehive coke. Seven new by-product plants were built in Ohio between 1915 and 1918. The largest steel producers of the Pittsburgh district began the construction of by-product works. Alabama added a new plant in 1917. The distant center of steel production in the Rocky Mountains changed from beehive to by-product coke when the Colorado Fuel & Iron Co.'s plant at Minnequa, near Pueblo, began operating in 1918. Still other furnace plants were added in the Buffalo, Chicago, and eastern Pennsylvania districts. Nor was construction confined to plants affiliated with steel works. In Indiana, Minnesota, and New Jersey by-product ovens were built to supply city gas, afford local reserves of foundry and domestic coke,

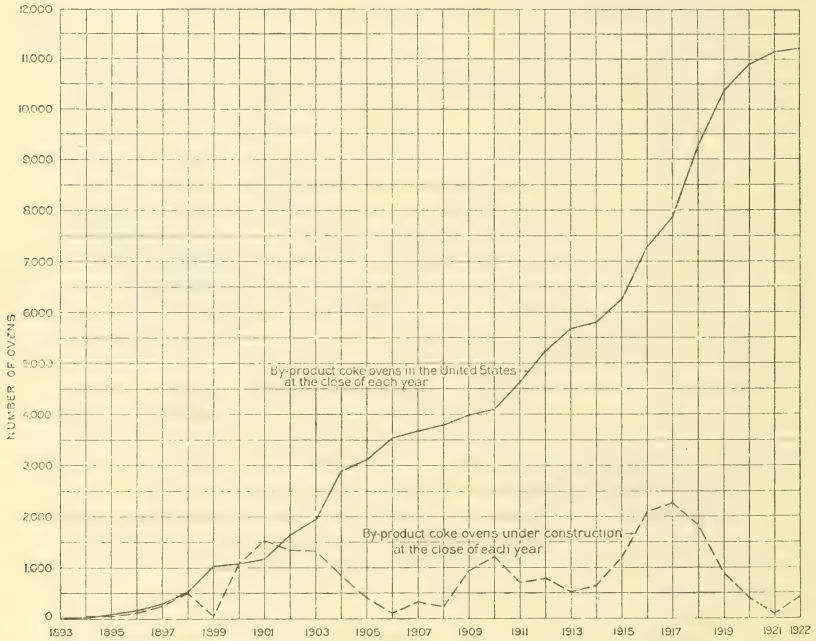


FIGURE 40.—By-product coke ovens completed and under construction in the United States at the end of each year, 1893–1922.

and meet the insistent demand for toluol. So numerous were the additions to the by-product industry that in November, 1918, the output of by-product coke for the first time passed that of beehive coke.

Such construction as has continued since the war up to the end of 1922 has largely been the completion of projects for which contracts had been let before the armistice, and the plants at Providence, R. I.; Buffalo, N. Y.; Swedeland and Pittsburgh, Pa.; Fairmont, W. Va.; Birmingham, Ala.; Detroit, Mich.; Chicago, Ill.; and Indianapolis and Terre Haute, Ind., reflect the stimulus of the high war prices for coke and by-products. The business depression of 1921 exercised a restraining influence on new investment in the by-product coke industry, as in all other lines of business, and the number of new ovens under construction at the end of 1921 was the lowest since 1899.

NUMBER OF BEEHIVE COKE OVENS.

The rapid construction of by-product ovens in the second period—from 1909 to 1913—checked the further extension of the beehive oven. The number of beehive ovens, including rectangular ovens and all modified types in which partial combustion of the coal takes place and no by-products are saved, reached its maximum in 1910, when practically 100,000 ovens were in existence (fig. 41). In each year thereafter new construction has failed to equal the ovens abandoned, and by the end of 1921 the number had dropped to 66,014. No new beehive ovens were built in 1922, and 1,839 were abandoned; the total at the end of the year was 63,958 (Tables 20 and 21).

The figures of new construction of coke ovens in this and earlier reports of the Geological Survey represent entirely new plants or ovens and do not include old ovens repaired and placed in production, except as specifically so stated. It is not feasible, therefore, to strike a balance to show the number of ovens at the end of any year by adding to the number in existence at the end of the preceding year the number constructed and subtracting from the sum the number abandoned during the current year. It is possible to construct and put into operation a battery of ovens within one year. Some operators occasionally neglect to report "end ovens" used solely for the purpose of keeping the inside ovens warm.

STATISTICS.

TABLE 19.—*By-product coke ovens built and under construction in the United States at the end of each year, 1918, 1920, 1921, and 1922.*

State.	1918		1920		1921		1922	
	Built.	Under construction.	Built.	Under construction.	Built.	Under construction.	Built.	Under construction.
Alabama	847	324	1,081	90	1,141	30	1,196	----
Colorado	120	----	120	----	120	----	120	----
Illinois	626	88	794	100	894	5	899	----
Indiana	1,026	190	1,216	----	1,213	----	1,213	----
Kentucky	108	----	108	----	108	----	108	----
Maryland	180	180	300	----	300	----	300	----
Massachusetts	400	----	400	----	400	----	400	----
Michigan	269	120	389	----	390	----	390	----
Minnesota	220	----	220	----	220	----	220	----
Missouri	56	----	56	8	64	----	64	----
New Jersey	260	55	315	----	252	----	252	----
New York	615	60	732	----	732	----	692	----
Ohio	1,658	----	1,558	----	1,558	----	1,558	----
Pennsylvania	2,368	638	3,006	148	3,154	----	3,154	366
Rhode Island	----	40	40	----	40	----	40	----
Tennessee	24	----	24	----	24	----	24	----
Washington	20	----	20	----	20	----	20	----
West Virginia	214	120	274	----	274	----	274	37
Wisconsin	268	----	228	50	238	50	288	----
	9,279	1,815	10,881	396	11,142	85	11,212	403

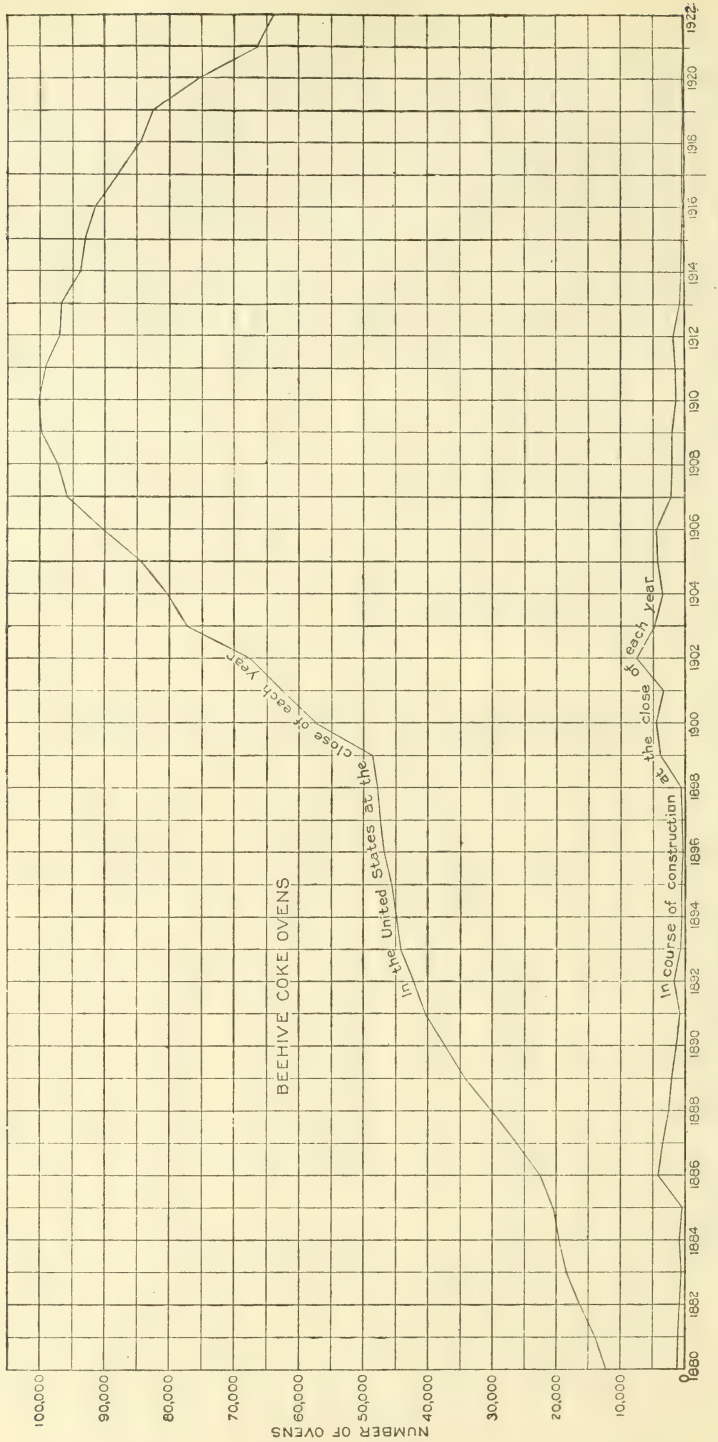


FIGURE 41.—Beehive coke ovens completed and under construction in the United States at the end of each year, 1880-1922.

TABLE 20.—*Beehive coke ovens in the United States at the end of each year, 1915, 1918, 1920, 1921, and 1922.*

State	1915	1918	1920	1921	1922
Alabama	8,568	8,586	8,482	6,717	6,460
Colorado	3,573	2,724	1,793	1,758	1,758
Georgia	201	201	151	151	151
Kansas	2	2			
Kentucky	1,097	1,077	855	855	795
Montana	112				
New Mexico	1,030	1,154	1,030	1,030	1,030
Ohio	321	272	222	205	205
Oklahoma	50	304	300	300	300
Pennsylvania	53,112	48,588	44,569	39,806	38,593
Tennessee	2,302	2,328	1,848	1,848	1,822
Utah	726	819	819	819	819
Virginia	5,229	4,042	3,906	3,474	3,372
Washington	331	408	407	408	408
West Virginia	16,228	14,130	10,916	8,643	8,245
Wisconsin	228				
	93,110	84,635	75,298	66,014	63,958

TABLE 21.—*Coke ovens completed and abandoned and total number in existence and under construction at the end of 1921 and 1922, by States.*

State.	Number of plants in existence.	Ovens.						
		New (completed during the year).[a]		Abandoned during the year.	In existence Dec. 31.		Under construction Dec. 31.	
		Number.	Capacity per day (net tons of coke).		Number.	Capacity per day (net tons of coke).	Number.	Capacity per day (net tons of coke).
1921.								
Beehive:								
Alabama	24			492	6,717	(b)		
Colorado	8				1,758	(b)		
Georgia	1				151	(b)		
Kentucky	5				855	(b)		
New Mexico	3				1,030	(b)		
Ohio	2			17	205	(b)		
Oklahoma	2				300	(b)		
Pennsylvania	169			5,044	39,806	(b)		
Tennessee	11				1,848	(b)		
Utah	1				819	(b)		
Virginia	14			482	3,474	(b)		
Washington	5				408	(b)		
West Virginia	58			2,103	8,643	(b)		
	303			8,138	66,014	(b)		
By-product:								
Alabama	7	60	780		1,141	13,057	30	390
Colorado	1				120	1,680		
Illinois	7	[c] 180	2,520		894	10,667	5	84
Indiana	6				1,213	14,476		
Kentucky	1				108	1,400		
Maryland	1				300	4,200		
Massachusetts	1				400	1,650		
Michigan	3				390	4,700		
Minnesota	3				220	2,360		
Missouri	1	8	101		64	813		
New Jersey	2	37	344	[d] 100	252	2,524		
New York	5				732	7,170		
Ohio	12				1,558	19,269		
Pennsylvania	13	148	1,694		3,154	31,158		
Rhode Island	1				40	510		
Tennessee	1				24	326		
Washington	1				20	70		
West Virginia	3				274	2,076		
Wisconsin	2	50	583	[d] 40	238	2,043	50	583
	71	483	6,022	140	11,142	120,149	85	1,057

[a] Represents new construction. Does not include old ovens repaired and put into commission.
[b] Data not available.
[c] Includes 80 ovens reported as new in 1920 but not put into operation until 1921.
[d] Replaced in part by new ovens at same location.

TABLE 21.—*Coke ovens completed and abandoned and total number in existence and under construction at the end of 1921 and 1922, by States*—Continued.

State.	Number of plants in existence.	Ovens.						
		New (completed during the year).		Abandoned during the year.	In existence Dec. 31.		Under construction Dec. 31.	
		Number.	Capacity per day (net tons of coke).		Number.	Capacity per day (net tons of coke).	Number.	Capacity per day (net tons of coke).
1922.								
Beehive:								
Alabama	23			360	6,460	(b)		
Colorado	8				1,758	(b)		
Georgia	1				151	(b)		
Kentucky	4			60	795	(b)		
New Mexico	3				1,030	(b)		
Ohio	2				205	(b)		
Oklahoma	2				300	(b)		
Pennsylvania	167			762	38,593	(b)	67	286
Tennessee	10			26	1,822	(b)		
Utah	1				819	(b)		
Virginia	14			102	3,372	(b)		
Washington	5				408	(b)		
West Virginia	56			529	8,245	(b)		
	296			1,839	63,958	(b)	67	268
By-product:								
Alabama	7	[c]55	687		1,196	12,828		
Colorado	1				120	1,680		
Illinois	7	5	84		899	10,786		
Indiana	6				1,213	15,135		
Kentucky	1				108	1,400		
Maryland	1				300	4,200		
Massachusetts	1				400	1,680		
Michigan	3				390	4,700		
Minnesota	3				220	2,128		
Missouri	1				64	813		
New Jersey	2				252	2,378		
New York	4			[f]40	692	5,138		
Ohio	12				1,558	19,417		
Pennsylvania	13				3,154	31,250	366	5,300
Rhode Island	1				40	510		
Tennessee	1				24	336		
Washington	1				20	89		
West Virginia	3				[c]274	2,330	37	600
Wisconsin	2	50	613		288	3,100		
	70	[c]110	1,384	[f]40	11,212	119,898	403	5,900

[b] Data not available.
[c] Includes 25 ovens completed but not put into operation until January, 1923.
[f] Abandoned after producing a small quantity of coke.

TABLE 22.—*By-product coke plants in the United States December 31, 1922.*

State.	Town.	Name of company owning plant.	Type of plant.[a]	Number of ovens.	Type of oven.	Year put in operation.[b]
Alabama	Alabama City	Gulf States Steel Co.	F	37	Koppers	1917
	Birmingham	Alabama By-Products Corporation.	M	75	do	1920–1923
	do	Sloss Sheffield Steel & Iron Co.	F	120	Semet-Solvay	1920
	Ensley	Alabama Co. and Republic Iron & Steel Co.	F	240	do	1898–1902
	Fairfield	Tennessee Coal, Iron & R. R. Co.	F	434	Koppers	1912–1920

[a] F, "Furnace plants," or plants associated with iron furnaces and steel works. M, "Nonfurnace plants" or "other plants" (see p. 693), including merchant plants, plants associated with industries other than iron and steel, and plants supplying gas under contract for city use.
[b] The first and last years are given for those plants that have two or more installations.

TABLE 22.—*By-product coke plants in the United States December 31, 1922*—Contd.

State.	Town.	Name of company owning plant.	Type of plant.	Number of ovens.	Type of oven.	Year put in operation.
Alabama	Tuscaloosa	Central Iron & Coal Co.	F	60	Semet-Solvay	1906–1914
	Woodward	Woodward Iron Co.	F	170	Koppers	1911–1922
	do	do	F	60	Wilputte	1917
Colorado	Pueblo	Colorado Fuel & Iron Co.	F	120	Koppers	1918
Illinois	Chicago	Chicago By-Product Coke Co.	M	105	do	1921–22
	Granite City	St. Louis Coke & Chemical Co.	F	80	Roberts	1921
	Joliet	Illinois Steel Co.	F	280	Koppers	1908–9
	Lockport	Coal Products Manufacturing Co.	M	18	Wilputte	1914
	do	do	M	35	Koppers	1912
	South Chicago	By-Products Coke Corporation.	M	280	Semet-Solvay	1905–1915
	do	International Harvester Co.	F	88	Wilputte	1919
	Waukegan	North Shore Gas Co.	M	13	Semet-Solvay	1912
Indiana	Gary	Illinois Steel Co.	F	700	Koppers	1911–1918
	Indiana Harbor	Inland Steel Co.	F	130	do	1913–1917
	do	Steel & Tube Co. of America.	F	120	Semet-Solvay	1919
	Indianapolis	Citizens Gas Co.	M	100	United-Otto	1909–1913
	do	do	M	41	Semet-Solvay	1914
	do	do	M	40	Wilputte	1919
	Muncie	Central Indiana Gas Co.	M	22	Klönne	1912
	Terre Haute	Indiana Coke & Gas Co.	M	30	GasMachinery	1916
	do	do	M	30	Koppers	1919
Kentucky	Ashland	Ashland By-Products Coke Co.	F	108	Semet-Solvay	1913–1916
Maryland	Sparrows Point	Bethlehem Steel Co.	F	300	Koppers	1914–1919
Massachusetts	Everett	New England Fuel & Transportation Co.	M	400	United-Otto	1899
Michigan	Dearborn	Ford Motor Co.	F	120	Semet-Solvay	1919
	Detroit	Solvay Process Co.	M	216	do	1901–1917
	Wyandotte	Michigan Alkali Co.	M	54	United-Otto	1902–1916
Minnesota	Duluth	Minnesota Steel Co.	F	90	Koppers	1915–16
	St. Paul	Minnesota By-Product Coke Co.	M	65	do	1918
	West Duluth	Zenith Furnace Co.	F	65	United-Otto	1904–1916
Missouri	St. Louis	Laclede Gas Light Co.	M	56	Koppers	1915
	do	do	M	8	Piette	1921
New Jersey	Camden	Camden Coke Co.	M	50	United-Otto	1903–1906
	do	do	M	37	Koppers	1921
	Kearney	Seaboard By-Product Coke Co.	M	165	do	1917–1919
New York	Buffalo	Donner Union Coke Corporation.	F	150	do	1920
	do	Wickwire Spencer Steel Corporation.	F	60	Semet-Solvay	1917
	Geneva	Empire Gas & Electric Co.	M	46	do	1904–1909
	Lackawanna	Bethlehem Steel Co.	F	94	United-Otto	1904
	do	do	F	60	Semet-Solvay	1920
	do	do	F	282	Rothberg	
Ohio	Canal Dover	Hanna Furnace Co.	F	24	Roberts	1916
	Canton	United Alloy Steel Corporation.	F	47	Koppers	1916
	Cleveland	American Steel & Wire Co.	F	180	do	1918
	do	McKinney Steel Co.	F	204	do	1916
	do	Otis Steel Co.	F	100	Semet-Solvay	1910–1915
	Ironton	Ironton By-Product Coke Co.	F	60	do	1918
	Lorain	National Tube Co.	F	208	Koppers	1918
	Portsmouth	Portsmouth By-Product Coke Co.	F	108	Semet-Solvay	1917
	Toledo	Toledo Furnace Co.	F	94	Koppers	1916
	Youngstown	Brier Hill Steel Co.	F	84	do	1917
	do	Republic Iron & Steel Co.	F	143	do	1914–15
	do	Youngstown Sheet & Tube Co.	F	306	do	1916–1918
Pennsylvania	Bethlehem	Bethlehem Steel Co.	F	424	do	1915–16
	Chester	Philadelphia Suburban Gas & Electric Co.	M	40	Semet-Solvay	1904
	Clairton	Carnegie Steel Co.	F	768	Koppers	1918–19
	Dunbar	American Manganese Manufacturing Co.	F	110	Semet-Solvay	1896–1903

TABLE 22.—*By-product coke plants in the United States December 31, 1922*—Contd.

State.	Town.	Name of company owning plant.	Type of plant.	Number of ovens.	Type of oven.	Year put in operation.
Pennsylvania	Farrell	Carnegie Steel Co	F	212	Otto-Hoffmann.	1903
	Franklin	Cambria Steel Co	F	92	Koppers	1915
	do	do	F	210	United-Otto	1895–1907
	do	do	F	190	Cambria	1918–1920
	Glassport	Allegheny By-Product Coke Co.	M	120	United-Otto	1897
	Lebanon	Bethlehem Steel Co	F	90	Semet-Solvay	1904–1921
	Midland	Pittsburgh Crucible Steel Co.	F	100	Koppers	1920
	Pittsburgh	Jones & Laughlin Steel Co.	F	300	do	1919–20
	Rosedale	Cambria Steel Co	F	88	Semet-Solvay	1921
	do	do	F	120	Cambria	1918–1921
	Steelton	Bethlehem Steel Co	F	120	Semet-Solvay	1907
	do	do	F	60	Koppers	1918
	Swedeland	Rainey-Wood Coke Co	F	110	do	1919
Rhode Island	Providence	Providence Gas Co	M	40	do	1919
Tennessee	Altonpark	Chattanooga Coke & Gas Co.	M	24	Semet-Solvay	1915
Washington	Seattle	Seattle Lighting Co	M	20	Klönne	1914
West Virginia	Benwood	National Tube Co	F	120	Semet-Solvay	1898–1901
	Fairmont	Domestic Coke Corporation.	M	60	Koppers	1920
	Follansbee	La Belle Iron Works	F	94	do	1917
Wisconsin	Mayville	Steel & Tube Co. of America.	F	108	Otto-Hoffmann.	1914–1917
	Milwaukee	Milwaukee Coke & Gas Co.	M	80	Semet Solvay	1904–1906
	do	do	M	100	Koppers	1921–22

TABLE 23.—*By-product ovens under construction in the United States December 31, 1922.*

State.	Town.	Name of company owning plant.	Number of ovens.	Type of oven.	Date of operation.
Pennsylvania	Clairton	Carnegie Steel Co	366	Koppers	June, 1924
West Virginia	Weirton	Weirton Steel Co	37	do	July, 1923

The types of by-product ovens now in existence in each State are shown in Table 24. The Koppers type now constitutes 57 per cent of the total number and was the only type to increase in number during 1922. The capacities of different types of ovens were discussed in Mineral Resources for 1921, Part II, pages 394–395.

TABLE 24.—*By-product ovens of each type in the United States at the end of the year in 1921 and 1922.*

State.	Koppers.	Semet-Solvay.	United Otto.[a]	Rothberg.	Gas Machinery.	Roberts.	Klönne.	Wilputte.	Piette.	Cambria-Belgian.	Total.
1921.											
Alabama	661	420						60			1,141
Colorado	120										120
Illinois	415	293				80		106			894
Indiana	860	161	100		30		22	40			1,213
Kentucky		108									108
Maryland	300										300
Massachusetts			400								400
Michigan		336	54								390

[a] Includes the Otto-Hoffman and Schniewind types.

TABLE 24.—*By-product ovens of each type in the United States at the end of the year in 1921 and 1922*—Continued.

State.	Koppers.	Semet-Solvay.	United Otto.	Rothberg.	Gas Machinery.	Roberts.	Klönne.	Wilputte.	Piette.	Cambria-Belgian.	Total.
1921.											
Minnesota	155		65								220
Missouri	56								8		64
New Jersey	202		50								252
New York	150	206	94	282							732
Ohio	1,266	268				24					1,558
Pennsylvania	1,854	448	542							310	3,154
Rhode Island	40										40
Tennessee		24									24
Washington							20				20
West Virginia	154	120									274
Wisconsin	50	80	108								238
	6,283	2,464	1,413	282	30	104	42	206	8	310	11,142
1922.											
Alabama	716	420						60			1,196
Colorado	120										120
Illinois	420	293				80		106			899
Indiana	860	161	100		30		22	40			1,213
Kentucky		108									108
Maryland	300										300
Massachusetts			400								400
Michigan		336	54								390
Minnesota	155		65								220
Missouri	56								8		64
New Jersey	202		50								252
New York	150	166	94	282							692
Ohio	1,266	268				24					1,558
Pennsylvania	1,854	448	542							310	3,154
Rhode Island	40										40
Tennessee		24									24
Washington							20				20
West Virginia	154	120									274
Wisconsin	100	80	108								288
	6,393	2,424	1,413	282	30	104	42	206	8	310	11,212

CAPACITY OF COKE OVENS.

Capacity of by-product ovens.—The capacity of the by-product ovens completed up to the end of 1922 was 119,898 tons of coke a day. The capacity of the 403 ovens under construction at the end of the year was 5,900 tons of coke a day. The distribution of these aggregate capacities, by States, is shown in Table 21.

Capacity as thus stated is defined as the total quantity of coke of the grade which the operator aims to produce that can be obtained with all conditions favorable and all ovens active. This capacity depends not only on the amount of coal placed in the ovens but upon many other factors, among them the temperature that can be maintained in the walls of the oven, which is limited by the character of the refractory materials used; the character and the quality of the coal used; and the width of the oven chambers. The effect of these several influences is discussed in Mineral Resources for 1921, Part II, pages 393–394.

The capacities at the end of 1922 reported for the several States in Table 21 show some differences from those reported for the same States at the end of 1921, even where the number of ovens has not changed. Certain of the changes are due to substitution of more

accurate figures from the companies in place of estimates formerly used by the Geological Survey; others to revision by the companies of their own plant ratings, due perhaps to change in coking practice.

The total yearly capacity of the ovens completed on December 31, 1922, was, in round numbers, 43,800,000 tons of coke. Completion of the ovens under construction at the end of the year would raise this total to 45,900,000 tons. In practice it is impossible to operate continuously at 100 per cent of capacity, for most plants are handicapped from time to time by shortage of coal, mechanical breakdowns, lack of labor, and other difficulties. As the experience of the war period shows,[5] an average operation for the country as a whole of 85 per cent of maximum capacity, or at the most 90 per cent, appears to be the upper limit of probable performance. Table 25 shows the estimated annual potential capacity of the by-product plants completed on three different dates when run at different percentages of their maximum capacity. From January 1, 1919, to January 1, 1923, the potential capacity increased by 10,100,000 tons a year. The end of 1922 found the country equipped with plants, either built or in course of construction, capable of producing by-product coke at the rate of 39,000,000 to 41,000,000 tons, or, say, 40,000,000 tons a year.

TABLE 25.—*Estimated annual potential production of coke and coal required for charge in millions of net tons, of by-product coke ovens in the United States, 1918, 1920, and 1922, when operated at different percentages of maximum capacity.*

Percentage of maximum capacity.	1918		1920		1922			
	Coke.	Coal.[a]	Coke.	Coal.[a]	Ovens completed Dec. 31.		Including ovens under construction.	
					Coke.	Coal.[a]	Coke.	Coal.[a]
100	33.7	48.1	42.8	61.2	43.8	62.6	45.9	65.6
90	30.3	43.3	38.5	55.0	39.4	56.3	41.3	59.0
85	28.6	40.9	36.4	52.0	37.2	53.2	39.0	55.8
75	25.3	36.1	32.1	45.9	32.9	47.0	34.4	49.2
50	16.8	24.0	21.4	30.6	21.9	31.3	23.0	32.8

[a] Coal for charge estimated on basis of 70 per cent yield in coke.

Table 26 shows the relation between the production of by-product coke and the maximum capacity for each month from January, 1920, to December, 1922. The same data are presented graphically in Figure 32 (p. 676). The average percentage of capacity attained in actual output for 1920 was 74.8, practically three-fourths of the theoretical capacity. In the depression of 1921 the operating ratio dropped to 45.8 per cent, and in 1922 it was less than two-thirds, namely, 64.6 per cent. The highest record for a single month during the period, reached in October, 1920, when supplies of coal were ample and demand was still active, was 82.8 per cent for the country as a whole. These records prove beyond doubt that operation at more than 90 per cent of maximum capacity under the actual conditions of the coal and coke market is not practicable over the country as a whole, however favorable may be the showing for particular plants.

[5] U. S. Geol. Survey Mineral Resources, 1918, pt. 2, pp. 1458–1473, 1921.

TABLE 26.—*Percentage of maximum capacity produced by by-product coke operators, by months, January, 1920, to December, 1922.*

Month.	1920	1921	1922	Month.	1920	1921	1922
January	72.0	62.3	50.4	July	75.8	35.1	66.7
February	74.1	57.3	53.4	August	78.1	37.5	48.2
March	77.4	48.6	57.4	September	80.7	39.7	62.3
April	67.2	42.7	59.2	October	82.8	45.9	75.4
May	68.7	43.4	68.1	November	77.8	48.4	81.2
June	73.4	39.4	69.2	December	69.5	49.7	82.2
				The year	74.8	45.8	64.6

Capacity of beehive ovens.—In spite of the abandonment of large numbers of beehive ovens, the capacity of those still in existence appears ample to meet any probable demand upon the beehive-coke industry. The aggregate capacity of the existing beehive ovens can not be precisely stated. It amounts to at least 36,000,000 tons a year and perhaps is as high as 45,000,000 tons; for most purposes it may be taken as 42,000,000 tons. In Mineral Resources for 1921, Part II, pages 388–389, are presented statistics of the daily capacity of the beehive ovens in each State, based upon reports from the operators. It has been found, however, that variations in practice to meet the changing conditions in the market and uncertainties in translating daily rates into annual rates where both 48 and 72 hour coke are commonly made by the same ovens have introduced so large an error into the figures that they are not reprinted here. The typical beehive oven will yield 4½ tons of coke per draw, with the maximum charge of coal, and if 48-hour coke is drawn twice and 72-hour coke once during the week—the common practice—such an oven will yield 13½ tons of coke a week, or about 700 tons a year. There are, however, many ovens of smaller capacity and still others, notably those of the rectangular type, whose capacity is larger. The variations in the quantity of coal charged under different operating conditions and in the coking time will affect the annual output from a given battery of ovens, even when they are in blast every day of the year.

Operation at 100 per cent of capacity is even less possible in the beehive industry than in the by-product industry. A record kept by the producers in the Connellsville district during the war and published in Mineral Resources for 1918, Part II, pages 1442, 1455–1456, shows that many causes may intervene to prevent operation at full capacity—chiefly car shortage, labor shortage and strikes, necessary repairs to ovens, disability of the mines supplying coal, and, in times of dull market, lack of orders. The highest percentage of the rated capacity attained in actual output in any week from August, 1917, to January, 1919, was 77.8 per cent, reached in the week of September 14, 1918. During the traffic congestion in 1918 the output dropped to 47 per cent of capacity, the principal cause of loss being shortage of coke cars. The average percentage for the year 1918 was 68.7.

The figure of 42,000,000 tons being accepted as the maximum capacity of the beehive ovens in existence at the end of 1922, and 70 per cent being taken as the highest percentage of maximum capacity to be

expected in actual operation, it appears that the ovens still in existence are capable of producing 29,000,000 or 30,000,000 tons a year. The maximum annual production of beehive coke was 35,000,000 tons, in 1916. It is clear that the ovens still remaining are ample to meet any demand that can possibly fall to them in view of the greatly increased capacity of the by-product plants. This statement, it should be noted, applies to the physical capacity of the ovens. The present labor supply would have to be increased to attain this production.

Comparison of oven capacity and requirements.—The foregoing analysis indicates a plant capacity, on the assumption of 85 per cent operation for retort ovens and 70 per cent for beehive ovens, sufficient to produce 69,000,000 tons of coke annually, of which 40,000,000 tons is by-product coke and 29,000,000 tons beehive coke. How does this figure compare with the possible requirements of the country? It is substantially in excess of the United States Fuel Administration's estimates on the requirements of coke consumers during 1918, which amounted, exclusive of sales of gas-house coke, to 59,645,000 tons.[6] Even when allowance is made for considerable increase in maximum requirements since 1918, it is evident that the aggregate capacity of the coke industry is sufficient to meet them.

Particular interest attaches to the ratio of by-product oven capacity to total requirements because of the opinion held by some in the coke trade that there is a limit to the profitable expansion of the by-product industry. It is reasoned that the construction of new by-product ovens will be arrested when a total capacity is reached sufficient to supply the demand for coke in years of inactive business, the task of meeting the additional demands in boom years being left to the more elastic beehive industry. Aside from the depression of 1921, only in two years in the last decade has the production of all coke fallen below 40,000,000 tons, the figure of maximum yield of by-product coke derived above. One of those years was 1922, when the coal strike artificially curtailed the production of coke. The other was the depression year of 1914, in which the output was 34,500,000 tons. The average production for the ten years ending 1920 was 46,400,000 tons. The estimated by-product oven capacity, 40,000,000 tons, is 71 per cent of the coke produced in 1918, the largest quantity ever consumed and exported in one year. It is 69 per cent of the coke required to produce 52,429,000 tons of pig iron, the annual capacity of the coke-burning blast furnaces completed or under construction on December 31, 1922, according to the annual statistical reports of the American Iron and Steel Institute, the consumption of coke being taken at 2,200 pounds to the gross ton of iron. It is also 67 per cent of the Fuel Administration's estimate of total requirements for coke less sales of gas-house coke.

COAL USED IN THE MANUFACTURE OF COKE.

The quantity of coal used in the manufacture of coke has been increasing at a rapid rate during the last 30 years, but the percentage of the total output of bituminous coal carbonized each year has shown no increase. As indicated by the lower of the two curves in Figure 42

[6] U. S. Fuel Adm., Report of distribution division, pt. 1, p. 69.

the average percentage carbonized has been about 15 in years of business activity. The downward jogs in this curve correspond to the years of general industrial depression, when the output of steel was low. They show that the consumption of coal for coke manufacture decreases more sharply in periods of business depression than the consumption for railroad, general industrial, and, most of all, domestic purposes. During 1921 the proportion of the total output made into coke shrank to 8.5 per cent, following the extreme prostration of the steel industry. In 1922 it rose to 12.7 per cent, a figure still below normal.

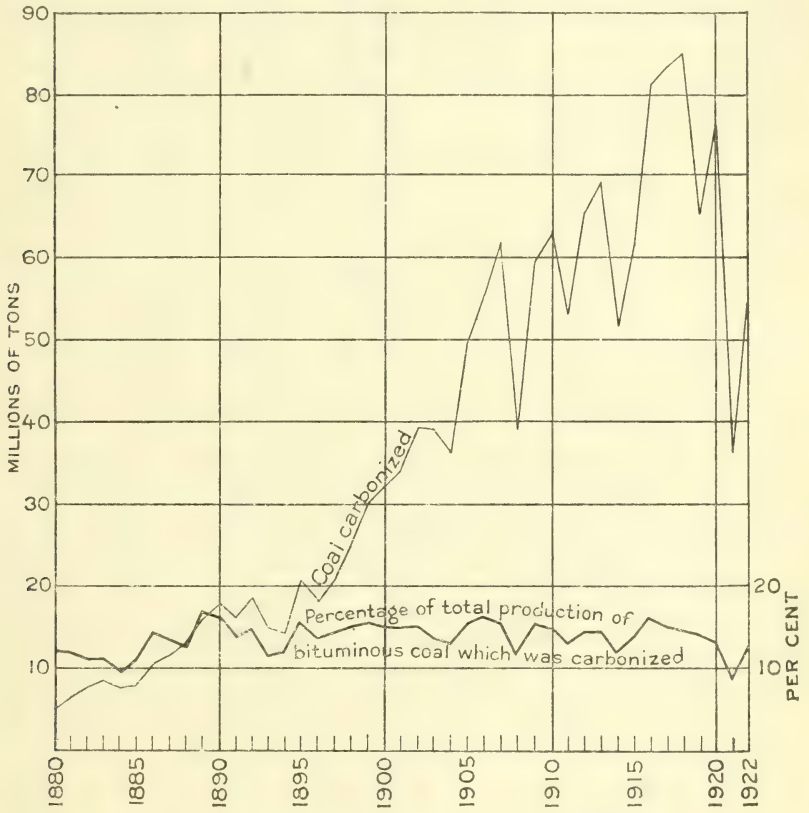


FIGURE 42.—Coal consumed in the manufacture of coke, 1880–1922.

The quantity of the coal charged into the ovens in each State and the value at the ovens are shown in Table 27. The cost of coal is the chief item of expense in the manufacture of coke. In 1922 it ranged from $1 a ton in Utah, where beehive coke is made at the mines from raw coal and the value placed thereon is solely a bookkeeping value, to $6.79 in Minnesota, where most of the coal must be hauled by rail, lake, and rail.

The average cost of coal used in beehive ovens was $2.61 a ton, and the cost of the coal equivalent of a ton of merchantable coke was $4.05.

TABLE 27.—*Total quantity and value at ovens of coal used in the manufacture of coke in the United States in 1922, by States.*

State.	Coal used (net tons).	Cost.		Coal per ton of coke.	
		Total.	Per ton.	Net tons.	Cost.
By-product plants.					
Alabama	5,115,981	$12,630,514	$2.47	1.46	$3.61
Colorado	528,956	2,382,792	4.50	1.45	6.53
Illinois	2,876,987	17,019,771	5.92	1.45	8.58
Indiana	5,509,297	31,404,367	5.70	1.38	7.87
Kentucky	629,012	2,690,701	4.28	1.38	5.91
Michigan	1,578,357	8,914,007	5.65	1.38	7.80
Minnesota	688,007	4,670,302	6.79	1.49	10.12
New York	2,208,162	12,357,964	5.60	1.48	8.29
Ohio	7,133,358	35,969,214	5.04	1.45	5.86
Pennsylvania	10,363,792	39,204,401	3.78	1.45	5.48
Tennessee	37,061	142,153	3.84	1.35	5.18
Washington	9,390	51,673	5.50	1.67	9.19
West Virginia	757,877	3,081,474	4.07	1.51	6.15
Maryland, Massachusetts, Missouri, New Jersey, Rhode Island, and Wisconsin	3,616,433	23,496,392	6.50	1.41	9.17
	41,052,670	194,015,725	4.73	1.44	6.81
Beehive plants.					
Alabama	509,661	1,306,423	2.56	1.66	4.28
Colorado	183,627	629,865	3.43	1.54	5.28
Georgia	16,178	68,096	4.21	1.83	7.70
Kentucky	53,660	167,143	3.11	1.76	5.47
New Mexico	141,340	397,165	2.81	1.61	4.52
Ohio	153,034	662,471	4.33	1.54	6.67
Pennsylvania	10,416,729	26,787,513	2.57	1.52	3.91
Tennessee	174,945	537,119	3.07	2.02	6.20
Utah	299,499	300,414	1.00	1.74	1.74
Virginia	601,528	1,503,529	2.50	1.59	3.98
Washington	40,825	215,965	5.29	1.57	8.31
West Virginia	694,842	2,126,419	3.06	1.66	5.08
	13,285,868	34,702,122	2.61	1.55	4.05

The average cost per ton of the coal charged in by-product ovens in 1922, reckoned f. o. b. ovens, was $4.73, a slight decrease as compared with 1921 (Table 28). The decrease does not represent a decline in market prices, for spot prices were higher in 1922 than in 1921. It is rather to be accounted for by the fact that much of the coal charged in 1921 was purchased or contracted for during the panicky market of 1920, and conversely that much of the coal charged in 1922 was delivered on contracts made in the dull year 1921. The effect of the strike of 1922 upon the coal supply of plants dependent upon the by-product coking coals of Pennsylvania is clearly shown. Against an average cost in Pennsylvania of $3.39 in 1921, the average for 1922 rose to $3.78.

TABLE 28.—*Average cost per ton of coal charged into by-product coke ovens, 1913–1922.*

State.	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Alabama	$1.57	$1.57	$1.65	$1.89	$2.54	$3.29	$3.35	$4.10	$3.29	$2.47
Illinois	2.91	2.82	2.87	2.93	3.81	4.63	4.73	6.49	5.90	5.92
Indiana	3.11	2.84	2.94	3.05	3.87	4.50	4.63	5.92	5.89	5.70
Kentucky	1.43	1.51	1.47	1.52	2.55	3.34	3.40	4.84	4.20	4.28
Michigan	2.37	2.43	2.38	2.48	3.63	4.51	4.60	7.03	5.77	5.65
Minnesota	2.75	2.75	2.72	2.94	4.01	5.31	4.33	6.50	7.12	6.79
New York	2.47	2.51	2.50	2.73	4.33	4.46	4.34	6.20	5.86	5.60
Ohio	2.07	1.96	1.88	2.56	4.36	3.98	3.85	5.75	4.94	5.04
Pennsylvania	2.13	2.02	2.01	2.47	3.29	3.74	2.99	3.91	3.39	3.78
Tennessee			1.64	1.66	2.08	3.59	3.64	4.30	3.84	3.83
Washington		3.31	3.34	3.38	3.87	5.72	5.89	6.63	6.53	5.50
West Virginia	2.09	1.99	1.88	2.00	3.30	3.57	3.18	4.82	3.89	4.06
Average	2.43	2.31	2.33	2.60	3.70	4.23	3.96	5.40	4.84	4.73
Cost of coal per ton of coke	3.27	3.19	3.24	3.62	5.20	6.00	5.65	7.73	7.03	6.81

The average value of the coke produced is compared with the cost of the coal per ton of coke in Table 29 and Figure 43. Thus in 1922 the value of beehive coke per ton as reported by the operators was $5.84, while the cost of the coal charged in the ovens per ton of coke drawn was $4.05. It must not be assumed that the margin of $1.79 between these two figures represents profit, for coal is only one item of the costs of the operators. Out of this difference must come the cost of labor, allowance for depreciation of plants and equipment, and all overhead charges, as well as taxes, before any profit can be shown.

The margin between the value of by-product coke and the cost of coal, shown in the second half of the diagram, is extremely small, and were it not for the by-products the operator of retort ovens would be losing money. In most of the years shown the cost of coal per ton of coke has been less than the reported value of the coke, but in 1921 and again in 1922 the cost of coal exceeded the value of the coke. Thus in 1922 the average value of the coke produced, according to by-product operators, including their own estimates of the value of the quantity used in associated works but not sold, was $6.59 a ton, but the average cost of coal per ton of coke was $6.81. The deficit, if made up at all, had to come from the by-products, which had a value that year of $3.32. The total value of all products was $9.91 per ton of coke produced, leaving a difference between the value of products and cost of coal of $3.10. Though larger than in 1921 this was smaller than in any other year since 1915. It must be emphasized again that this difference between value of products and cost of coal is not profit, and the deductions for capital charges in the manufacture of by-product coke are of course very much greater than the corresponding deduction for beehive coke.

These comparisons are subject to the comment before made, that where coking operations are subsidiary to the manufacture of pig iron the value placed upon the product may be arbitrary and quite different from the average market price. Where this is true, however, the average cost of coal may be also a nominal figure, because the plants associated with iron furnaces are commonly supplied with coal from mines owned by the same financial interests. The comparison therefore probably indicates in general terms the trend in cost and value from year to year.

TABLE 29.—*Cost of coal and value of all products per ton of coke produced, 1913–1922.*

[All figures reduced to value per ton of coke produced.]

Year.	Beehive coke.			By-product coke.				
	Value of coke per ton.[a]	Cost of coal.	Excess, coke over coal.	Value of coke per ton.[a]	Value of all by-products.	Total value of products.	Cost of coal.	Excess, products over coal.
1913	$2.39	$1.75	$0.64	$3.82	$1.41	$5.23	$3.27	$1.96
1914	2.15	1.67	.48	3.39	1.65	5.04	3.19	1.85
1915	2.07	1.61	.46	3.45	2.19	5.64	3.24	2.40
1916	2.69	1.96	.73	3.95	3.25	7.20	3.62	3.58
1917	4.81	3.17	1.64	6.18	3.01	9.19	5.20	3.99
1918	6.21	3.65	2.56	7.42	3.07	10.49	6.00	4.49
1919	5.15	3.39	1.76	6.37	2.72	9.09	5.65	3.44
1920	[b]7.94	4.90	3.04	10.15	3.40	13.55	7.73	5.82
1921	5.45	3.82	1.63	5.95	3.46	9.41	7.03	2.38
1922	5.84	4.05	1.79	6.59	3.32	9.91	6.81	3.10

[a] Includes operators' statements of the value of coke consumed by them in associated enterprises but not sold, except that in 1918 and 1920 the value of such coke was estimated by the Geological Survey for each State at the average value for that State of the part of the product reported sold.

[b] Revised from preceding report.

FIGURE 43.—Cost of coal and value of all products per ton of coke produced, 1913–1922.

Shaded bars represent value of coke per ton, and white extensions on bars for by-product coke represent the value of by-products per ton of coke.

The coal charged in by-product ovens is generally purchased as run of mine. In some districts the coal is washed before coking in order to lower the ash content and remove sulphur. Most of the coal charged in both beehive and by-product ovens in Alabama in 1922 was washed, and all of that in Colorado, Georgia, New Mexico, and Washington was washed. Washing is also practiced in some districts of Pennsylvania and in Tennessee but is not applied to the great bulk of by-product coal produced in West Virginia, Virginia, eastern Kentucky, and Pennsylvania. (See Table 30.)

It is the almost universal practice in by-product oven operation to crush the coal before charging it in the oven. In the beehive-

coke industry the practice varies with the district, as is shown in Table 31. Of the 13,286,000 tons of coal charged in beehive ovens during 1922, 5,069,000 tons, or 38 per cent, was charged in plants where the practice was to crush the coal (including a few plants that charge screenings), and 8,217,000 tons, or 62 per cent, was used at plants which reported that crushing was not practiced. In the Connellsville district crushing is seldom practiced, but it is the rule in Colorado, New Mexico, Tennessee, Utah, and Virginia and is common in Alabama and West Virginia and in districts of Pennsylvania outside the Connellsville region. Crushing the coal insures a somewhat more even fusing in the coking process than is attained when both lumps and fines are charged together, and the advantage of crushing is therefore greatest when the coal used naturally contains a high percentage of lump.

TABLE 30.—*Coal used in the manufacture of beehive and by-product coke in the United States, 1918, 1920, 1921, and 1922, in net tons.*

State.	1918	1920	1921	1922		
				Unwashed.	Washed.	Total.
By-product ovens:						
Alabama	3,877,634	4,542,279	3,476,923	129,882	4,986,099	5,115,981
Colorado	345,877	730,870	417,112	----------	528,956	528,956
Illinois	3,199,620	3,090,862	1,952,358	2,759,784	117,203	2,876,987
Indiana	5,318,900	6,355,846	4,342,467	5,241,527	267,770	5,509,297
Kentucky	723,113	671,866	257,854	629,012	----------	629,012
Maryland	696,576	953,404	395,526	799,630	----------	799,630
Massachusetts	676,866	630,365	399,935	606,589	----------	606,589
Michigan	(a)	1,902,224	1,103,524	1,578,357	----------	1,578,357
Minnesota	1,069,775	942,869	630,173	688,007	----------	688,007
Missouri	(a)	(a)	(a)	(a)	----------	(a)
New Jersey	994,300	1,012,562	1,064,960	1,084,781	----------	1,084,781
New York	1,516,580	1,504,902	1,098,014	2,208,162	----------	2,208,162
Ohio	7,775,623	8,151,987	4,375,992	7,133,358	----------	7,133,358
Pennsylvania	6,514,868	11,325,505	7,865,395	9,381,020	982,772	10,363,792
Rhode Island	----------	(a)	(a)	(a)	----------	(a)
Tennessee	166,157	183,200	79,911	----------	37,061	37,061
Washington	47,410	44,594	43,570	----------	9,390	9,390
West Virginia	853,684	626,196	277,345	757,877	----------	757,877
Wisconsin	(a)	(a)	(a)	(a)	----------	(a)
Combined States	3,090,738	1,535,465	932,052	1,125,433	----------	1,125,433
	36,867,721	44,204,996	28,713,111	34,123,419	6,929,251	41,052,670
Beehive ovens:						
Alabama	2,949,992	1,488,755	223,119	82,327	427,334	509,661
Colorado	1,216,154	422,244	123,828	----------	183,627	183,627
Georgia	38,280	29,804	12,708	----------	16,178	16,178
Kentucky	533,346	447,418	161,507	53,660	----------	53,660
New Mexico	1,047,675	(a)	(a)	----------	141,340	141,340
Ohio	223,200	139,144	99,787	153,034	----------	153,034
Oklahoma	(a)	----------	----------	----------	----------	----------
Pennsylvania	34,059,026	24,344,157	6,722,491	9,284,665	1,132,064	10,416,729
Tennessee	564,920	310,583	54,328	9,210	165,735	174,945
Utah	(a)	(a)	(a)	299,499	----------	299,499
Virginia	2,042,429	1,645,253	442,038	601,528	----------	601,528
Washington	154,460	47,876	6,291	----------	40,825	40,825
West Virginia	4,516,108	2,283,737	343,226	647,376	47,466	694,842
Combined States	814,707	826,865	286,123	----------	----------	----------
	48,160,297	31,985,836	8,475,446	11,131,299	2,154,569	13,285,868

[a] Included under "Combined States."

TABLE 31.—*Coal consumed in 1922 at beehive-coke plants, classified with respect to practice in crushing coal before charging, in net tons.*

State and district.	At plants practicing crushing.[a]	At plants not practicing crushing.	Total.
Alabama	372,858	136,803	509,661
Colorado	183,627		183,627
Georgia		16,178	16,178
Kentucky	41,615	12,045	53,660
New Mexico	141,340		141,340
Ohio		153,034	153,034
Pennsylvania:			
Allegheny Mountain and Allegheny Valley district	174,167	3,701	177,868
Connellsville district	50,691	5,849,413	5,900,104
Lower Connellsville district	729,070	1,846,543	2,575,613
Pittsburgh district	371,561		371,561
Upper Connellsville district	364,598	52,522	417,120
Other districts	960,571	13,892	974,463
Total Pennsylvania	2,650,658	7,766,071	10,416,729
Tennessee	174,945		174,945
Utah	299,499		299,499
Virginia	601,528		601,528
Washington	16,202	24,623	40,825
West Virginia:			
Flat Top district	59,254	75,048	134,302
Kanawha district	95,034		95,034
New River district	163,667		163,667
Upper Monongahela district	249,116	14,504	263,620
Upper Potomac and Tygarts Valley district	19,426	18,793	38,219
Total West Virginia	586,497	108,345	694,842
Total United States	5,068,769	8,217,099	13,285,868

[a] Includes a small number of plants that reported charging slack or screenings.

SOURCE OF BY-PRODUCT COAL IN 1922.

The dislocation of the normal movement of coal occasioned by the mine and rail strikes in 1922 is reflected in the statistics of coal consumed by by-product ovens. Supplies of high-volatile coking coal from the Connellsville region were greatly curtailed by the unexpected walkout of the nonunion miners. Hurried efforts to make up the deficit led to the quoting of freight rates from southern West Virginia to Pennsylvania points for the first time in traffic history. Pocahontas coal carried to Lake Erie ports moved eastward to Buffalo ovens. Operators on the north Atlantic seaboard were forced to go farther south than ever before and drew more heavily upon the coals of southwestern Virginia. The most striking feature of distribution in 1922 was the importation of British coking coals, which were used in Baltimore, Newark, Providence, and Boston.

Progress in the art of making coke from the higher-volatile, slow-coking coals of the Middle West has aroused particular interest in the quantity of Illinois and Indiana coal coked in by-product ovens. Coal from these States was used in 1922 at more plants than in 1917, for example, but the proportion of the total derived from these States showed little change. Against 446,000 tons of Illinois coal charged in by-product ovens in 1917, the reports for 1922 showed 840,000 tons. For Indiana coal the figures were 449,000 tons in 1917 and 466,000 tons in 1922.

The coals of Illinois and Indiana can be laid down cheaper at by-product plants in the Chicago and near-by territory because of the lower freights they pay. They are handicapped by the fact that to yield satisfactory metallurgical coke they generally require a slower rate of coking than it is necessary to maintain with the eastern coking coal. The speed of coking determines in part the capital cost per ton of coke, and the high overhead that must be assessed against the slow-coking coals may offset a difference in freight costs. Although there are numerous exceptions, it is a general rule that high-volatile coal requires a slow rate of coking and low-volatile coal permits a rapid rate of coking. For this reason, many operators mix low-volatile and high-volatile coal in order to improve the quality of coke produced and cut down the coking time. Pocahontas coal is the most conspicuous example of a low-volatile fast-coking coal. Hence the favor in which it is held for mixing with the high-volatile coals of eastern Kentucky and West Virginia, which are rich in by-products and gas. The Pittsburgh coal is high-volatile but relatively fast-coking. The coals of Illinois and Indiana are high-volatile and slow-coking and therefore require the longest time in the ovens, not only because they yield satisfactory coke only at relatively low temperatures but also because they contain more volatile matter to be given off.

Table 32 presents a summary of the replies of operators as to the origin of the coal used in the manufacture of by-product coke in 1922. Some operators could furnish the source of the coal purchased during the year but did not know the precise origin of the coal charged, and consequently the totals do not agree exactly with the data in Table 22. Some of the reports did not specify the tonnage received from each district, and the allocation of the total charged in each State between the several States of origin is, in part, estimated. The estimates, however, do not seriously impair the reliability of the results.

TABLE 32.—*Coal used in the manufacture of by-product coke in 1922, by sources, in net tons.*

State in which coal was used.	Coal produced in—						
	Alabama.	Arkansas.	Colorado.	Illinois.	Indiana.	Kentucky.	Oklahoma.
Alabama	5,114,121						
Colorado			528,956				
Illinois				564,137	65,650	[a] 1,498,000	
Indiana				268,119	400,585	[a] 1,140,000	
Kentucky						521,596	
Michigan						629,790	
Minnesota		[b]		[b]		[a] 103,000	
New Jersey						29,705	
New York						626,913	
Ohio						1,694,423	
Pennsylvania						[a] 558,000	
Missouri, Rhode Island, and Wisconsin				4,876		[a] 384,000	26,006
	5,114,121	[b]	528,956	[c] 840,132	466,235	7,185,427	26,006

[a] Estimated in part from incomplete reports.
[b] Small amount only, estimate for which is included in the total.
[c] Includes estimates for items not shown separately.

TABLE 32.—*Coal used in the manufacture of by-product coke in 1922, by sources, in net tons*—Continued.

State in which coal was used.	Coal produced in—					Coal imported from England.	Total.
	Pennsylvania.	Tennessee.	Virginia.	Washington.	West Virginia.		
Alabama							5,114,121
Colorado							528,956
Illinois	38,563				710,468		2,876,818
Indiana	213,240				[a] 3,528,000		5,549,944
Kentucky					107,416		629,012
Maryland	259,413				522,089	18,128	799,630
Massachusetts			[a] 139,000		[a] 358,000	[c] 109,000	606,000
Michigan	181,496				767,071		1,578,357
Minnesota	[a] 343,000				238,846		[c] 688,446
New Jersey	201,366		444,426		238,979	170,305	1,084,781
New York	1,282,322		142,000		156,927		2,208,162
Ohio	3,371,822		30,350		2,036,743		7,133,338
Pennsylvania	[a] 7,950,000				[a] 1,856,000		10,364,000
Tennessee		37,061					37,061
Washington				9,390			9,390
West Virginia	359,184				398,693		757,877
Missouri, Rhode Island, and Wisconsin	43,345		25,150		[a] 570,000	71,857	1,125,234
	14,243,751	37,061	780,926	9,390	11,489,232	369,290	41,091,127

[a] Estimated in part from incomplete reports.
[c] Includes estimates for items not shown separately.

YIELD OF COKE FROM COAL.

The percentage recovery of merchantable coke from coal charged decreased at beehive ovens in 1922, but increased at by-product ovens (Table 33). As before, the average for by-product practice was notably higher than for beehive practice—69.5 against 64.5 per cent. The lower yield in beehive ovens results from the fact that a small part of the coke itself is burned in order to produce the heat required for the coking operation.

TABLE 33.—*Percentage yield of coke from coal in beehive and by-product ovens in the United States, 1918, 1920, 1921, and 1922.*

State.	1918		1920		1921		1922	
	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.
Alabama	58.2	67.9	59.8	68.8	59.6	69.1	60.1	68.3
Colorado	62.4	69.5	64.6	70.7	65.7	68.7	65.0	68.9
Georgia	57.6		55.4		54.6		54.6	
Illinois		71.4		69.1		67.7		68.9
Indiana		73.3		71.6		71.2		72.5
Kentucky	56.4	73.9	60.9	69.5	61.6	71.9	56.9	72.6
Maryland		74.8		71.5		73.9		73.8
Massachusetts		82.2		77.4		78.5		67.1
Michigan		75.9		73.2		70.4		72.3
Minnesota		73.3		71.6		69.2		67.2
Missouri		75.2		72.0		70.8		69.3
New Jersey		68.6		71.7		69.5		72.9
New Mexico	57.0		54.4		71.8		62.0	
New York		70.5		69.1		68.0		67.7
Ohio	62.2	67.2	62.5	68.9	62.3	67.8	65.0	68.9
Oklahoma	58.2							
Pennsylvania	65.0	70.4	65.3	68.3	66.4	67.4	65.6	69.0
Rhode Island				66.3		70.0		70.0
Tennessee	53.6	74.9	52.3	75.9	51.5	72.2	49.4	74.1
Utah	56.3		56.8		57.3		57.6	
Virginia	60.4		62.5		63.5		62.9	
Washington	60.6	74.8	69.2	58.9	55.6	54.5	63.8	59.8
West Virginia	60.2	70.7	60.4	71.4	61.0	67.9	60.1	66.2
Wisconsin		73.4		70.0		66.5		67.8
Average	63.3	70.5	64.1	69.9	65.3	68.8	64.5	69.5

The trend of coke yields during recent years is made clear by the curves of Figure 44, but in examining these curves certain sources of error must be kept in mind. For example, the curve of average yield on all coke produced, including both beehive and by-product (curve A), shows sharp and sudden fluctuations in the years 1884, 1888, and 1899 that are probably due to inaccuracies in the original data—inaccuracies that can not be corrected now. Moreover, owing to a change in the method of reporting made in 1918, the curves before that date are not exactly comparable with those since. Up to 1918 operators did not always specify whether or not breeze was included in their reports of coke produced. Beginning with 1920, separate returns were made for breeze and merchantable coke. It is clear that most operators, even before 1918, reported only mer-

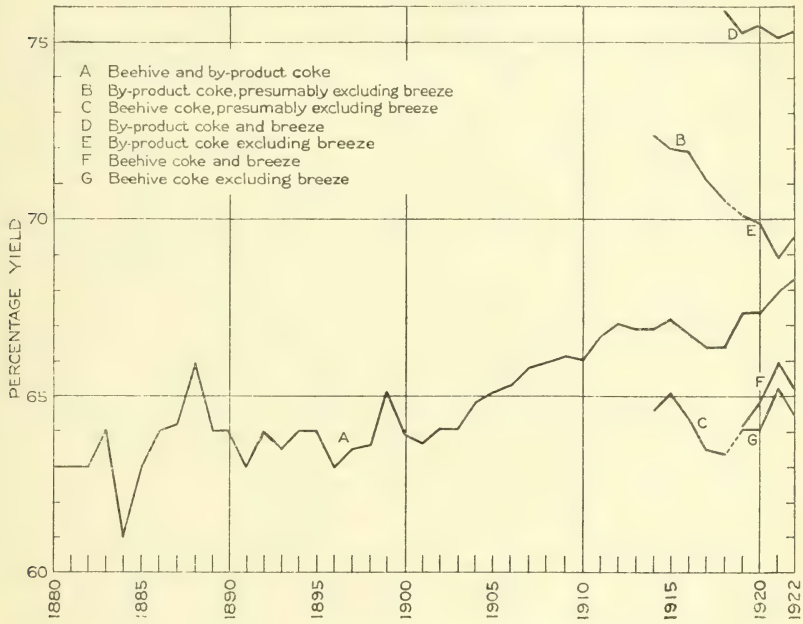


FIGURE 44.—Yield of coke from coal in by-product and beehive plants, 1880–1922.

chantable coke, and therefore the curves up to and including 1918 are approximately if not exactly comparable with those since 1918. Curve F, it should be noted, does not include breeze wasted.

The gradual substitution of by-product for beehive coke is the principal cause of the upward tendency of curve A, which represents the yield of coke from coal in both beehive and by-product plants.

Aside from the method of manufacture, the quantity of volatile matter present in the coal is the controlling factor in determining the percentage yield of coke obtained. Practically all the volatile matter is eliminated during coking, and the fixed carbon and the ash, with only a very small percentage of volatile matter, remain to form the coke.

Changes in the relative proportions of high-volatile and low-volatile coal charged are probably the chief cause of the decline in the yield of coke in by-product ovens, represented by curves B and E. Not

only has inferior coal been forced upon the by-product operators during the recurring shortages of the last five years, but the number of plants primarily dependent on high-volatile coal from the Pittsburgh and Connellsville regions has increased markedly. (See p. 704.)

COKE BREEZE.

It is inevitable that a considerable percentage of the coke made will be so fine as not to be suitable for blast-furnace or foundry use or for domestic fuel. This fine coke is separated by screening or hand forking and is commonly known as breeze.

Breeze is thus a size of coke, not a different product, though it runs higher in ash than the larger sizes. In beehive plants it is what passes through the tines of the loading forks or the screens of the loading machines, and its dimensions therefore vary. At by-product plants that produce domestic coke it may be defined precisely as the next size smaller than pea coke—that is, coke passing through a ¾-inch screen. At such plants breeze is strictly analogous to buckwheat anthracite.

It would be more logical to count breeze as part of the coke produced, but to do so would not conform to general trade usage. Moreover, comparisons of present with past production could not then be accurately made, for the records of breeze produced prior to 1916 are fragmentary. Hence it is treated in this report as a by-product, and the term "coke" refers only to the larger material from which the screenings have been removed.

There is a marked difference in beehive and by-product practice with respect to the treatment of breeze. In both branches of the industry the operator seeks to reduce the production of breeze to a minimum, because at best it commands a much lower price than the large coke. At beehive plants little use can be found for the breeze, and it is generally regarded by the operator as so much waste.

One of the advantages of by-product practice, however, is the possibility of utilizing breeze. Out of 2,395,286 tons produced at by-product plants in 1922, only 33,751 tons was wasted. The quantities produced and the uses made of breeze are shown in Tables 34 and 35. On properly designed grates breeze makes a satisfactory boiler fuel, and 1,587,000 tons, equivalent to 66 per cent of the breeze produced, was so used in 1922. Where the plant sells its surplus gas for city supply, it is sometimes profitable to make producer gas to fire the ovens, and breeze may well be used for this purpose. Breeze not needed by the over operator can frequently be sold to other industrial establishments in the neighborhood, without the expense of transportation by rail that is involved in selling breeze from most of the beehive plants. By-product operators reported sales of 526,000 tons of breeze in 1922 at an average of $3.01 a ton.

Beehive operators were also asked to report, for 1922, the quantity of screenings and breeze produced and sold, but only 34 of the plants active during the year had records to show these items. The replies of the 34 operators are summarized in the lower part of Table 35. The quantity reported as produced was 91,472 tons, valued at $226,875, but it is clear that this total was far short of the breeze actually produced at beehive plants. In general, the beehive-coke

industry still considers breeze as so much "ash" or waste. Of the screenings and breeze reported as produced, 26,865 tons was used for raising steam, 6,147 tons was used for other purposes, and 33,946 tons was sold for $112,657.

TABLE 34.—*Coke breeze recovered at coke plants in the United States in 1921, by States.*

State.	Yield (per cent of coal)	Produced.		Used by producer (net tons).	Sold.		Wasted (net tons).
		Net tons.	Value.		Net tons.	Value.	
By-product ovens.							
Alabama	4.5	155,568	$296,941	127,517	14,440	$31,768	2,576
Colorado	5.6	23,492	[a]	23,140		[a]	352
Illinois	6.3	123,061	269,677	80,739	35,725	104,821	
Indiana	5.8	254,056	407,063	207,208	10,578	18,177	
Kentucky	3.9	10,066	7,046		10,179	7,128	
Maryland	4.8	19,034	[a]	21,330	752	[a]	
Massachusetts	6.0	23,984	[a]		23,546	[a]	
Michigan	5.3	58,848	117,032	46,409	34,861	61,770	
Minnesota	6.7	42,329	86,675	39,232	1,782	3,845	2,817
New Jersey	5.7	60,621	[a]	45,772	15,227	[a]	
New York	5.0	54,868	147,740	74,924	785	5,845	
Ohio	7.5	327,672	456,658	275,971	35,772	26,117	
Pennsylvania	7.5	587,287	872,386	453,114	7,103	10,404	14,297
Tennessee	1.2	958	3,161		999	3,296	
Washington	15.1	6,594	3,956	6,595			
West Virginia	5.6	15,578	7,318	15,579	153	72	
Missouri, Rhode Island, and Wisconsin	6.0	67,094	102,566	55,089	13,965	34,287	
Undistributed							
	4.5	1,831,110	3,160,887	1,472,619	205,867	474,109	20,042
Beehive ovens.							
Alabama	[b] 4.5	6,916	20,944	4,850			[c]
Georgia	[b] 2.7	345	69		300	60	[c]
Pennsylvania	[b] 3.0	41,162	117,177	4,641	3,842	7,755	[c]
Utah	[b] 1.6	4,265			4,265	13,136	[c]
Colorado, New Mexico, Ohio, Virginia, and West Virginia	[b] 1.4	5,579	24,403	1,029	4,503	18,581	[c]
	[b] 2.7	58,267	162,593	10,520	12,910	39,532	[c]

[a] Included under "Undistributed."
[b] Yield computed by dividing the production of breeze at the few plants reporting by the quantity of coal charged at those plants.
[c] Data not available.

TABLE 35.—*Coke breeze recovered at coke plants in the United States in 1922, by States.*

State.	Yield (per cent of coal).	Produced.		Used for steam raising.		Used for other purposes by producer.		Sold.		Put in stock (net tons).	Wasted (net tons).
		Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.		
By-product ovens.											
Alabama	4.2	212,601	$499,898	126,916	$268,041	11,908	$26,119	34,863	$127,430	32,273	5,564
Colorado	7.1	37,753	(a)	28,684	(a)	8,221	(a)			848	
Illinois	5.4	154,595	357,602	87,706	203,331	16,157	35,979	78,593	184,539	9,782	
Indiana	5.7	312,868	687,854	259,893	557,854	54,056	110,847	72,794	206,120	4,209	
Kentucky	2.4	15,309	21,892					13,584	19,536		1,725
Maryland	1.4	11,078	(a)			3,213	(a)	2,961	(a)	4,874	
Massachusetts	6.3	38,367	(a)	18,366	(a)	1,206	(a)	11,448	(a)		
Michigan	4.7	74,901	149,176	91,720	214,366	276	480	37,830	65,618	303	
Minnesota	9.1	62,450	122,061	36,399	71,890	3,191	3,560	29,576	58,412	2,102	709
New Jersey	5.5	59,952	(a)	45,025	(a)	239	(a)	14,936	(a)		
New York	5.3	116,177	330,594	68,711	142,721	21,785	43,571	24,956	141,841	3,615	
Ohio	7.3	519,923	1,157,231	223,925	197,459	161,232	455,494	136,157	485,681	11,818	1,878
Pennsylvania	6.2	643,031	1,058,372	507,508	821,165	9,126	17,169	61,103	143,160	5,612	22,300
Tennessee	2.9	1,093	1,093					479	479	614	
Washington	10.9	1,026	1,026	1,488	1,488	4	4	16	56		
West Virginia	6.8	51,507	70,608	16,161	11,867	3,063	2,411	1,090	1,812		1,545
Missouri, Rhode Island, and Wisconsin	7.3	82,655	164,283	74,708	162,990	910	455	5,771	12,224	4,710	30
Undistributed			501,647		269,741		34,081		136,491		
	5.8	2,395,286	5,123,337	1,587,210	2,922,913	294,617	730,170	526,157	1,583,399	80,760	33,751
Beehive ovens.											
Pennsylvania	b 2.6	58,658	140,554	14,130	23,174	6,147	9,304	15,344	59,988		c 26,730
Tennessee	b 2.1	3,136	7,965	2,443	6,170						
Virginia	b 1.2	3,222	13,857					2,498	11,982		
West Virginia	b 0.3	261	951					200	800		c 61
Alabama, Colorado, Ohio, and Utah	b 3.8	26,195	63,548	10,292	23,653			15,904	39,887		
	b 2.7	91,472	226,875	26,865	52,997	6,147	9,304	33,946	112,657		c 26,791

[a] Included under "Undistributed."
[b] Yield computed by dividing the production of breeze at the few plants reporting by the quantity of coal charged at those plants.
[c] As reported; quantity produced but not used was undoubtedly greater.

DISPOSITION.

SALES.

The disposition of the coke produced in 1922 is given in Tables 36 and 37.

The production of by-product oven coke was 28,551,000 tons. Sales to the amount of 8,402,000 tons were reported, and 21,107,000 tons was used by the producer. The sum of the sales and the quantity used but not sold was nearly a million tons in excess of the production, the difference being drawn from stocks. (See pp. 736–737.)

Between the blast furnaces, which are the largest users of coke, and the coke plants there exists a close business relation, which, in many plants, amounts to identity of ownership. The proportion of the by-product coke reported as used by the producers in affiliated blast furnaces or steel plants was 74 per cent of the total, and even this high percentage does not indicate the full extent of the financial interrelationship of the by-product coke and iron industry, for, as shown in Table 9, fully 83.7 per cent of the coke produced in 1922 came from ovens associated with furnaces. Among such affiliated interests the line between sales and interdepartmental transfers is difficult to draw, and it is probable that a large part of the 2,935,000 tons of furnace coke reported as sold actually went to iron furnaces that are in some way connected with the coke companies.

A like uncertainty marks bookkeeping practice with respect to deliveries of coke from beehive ovens to affiliated iron and steel works. The producers reported in 1922 the sale of 6,105,000 tons of furnace coke, yet this figure includes the production of the H. C. Frick Co. and other "furnace" interests that do not sell on the open market but deliver their entire product to financially affiliated corporations.

Tables 36 and 37 also classify the sales as between "furnace coke," "foundry coke," and "domestic and other coke." These terms are general trade designations referring to physical or chemical properties of the coke, rather than to the precise uses to which the product is put. Not all foundry coke, for example, finds its way to foundrymen. In the beehive-coke trade furnace coke is commonly 48-hour coke, and foundry coke is supposed to be 72-hour coke, which commonly comes in larger, longer, and harder pieces than furnace coke and is selected with more care to prevent the loading of the soft pieces and black ends. To compensate for this extra work and for the heavier capital charges resulting from the longer coking time, foundry coke commonly sells at 50 cents to $1 a ton more. (See Table 47 and fig. 46.) The Fuel Administration price on Connellsville furnace coke, for example, was $6 a ton, and on 72-hour selected foundry coke it was $7. Under the actual conditions of the market the distinction in coking time is not always observed, and much so-called foundry coke is ordinary 48-hour furnace coke from which the soft pieces and black ends have been thrown out.

In the manufacture of by-product coke the universal practice of crushing the coal before coking and the facilities for screening and sizing the coke permit more precise definition of grades. In terms of size by-product furnace coke is run-of-oven coke from which the breeze and all small coke of less than say three-fourths inch in diam-

eter have been removed. By-product foundry coke is a blocky coke whose maximum size is much greater than that of furnace coke and from which all sizes under 2½ to 3 inches are screened out. Domestic coke includes all sizes of approximately 3 inches and under, exclusive of breeze. It may result from the screening of foundry coke or even furnace coke, or where the principal demand is for domestic coke it may be obtained by crushing the larger fragments.

The statistical returns for 1922 (Tables 36 and 37) indicate sales of foundry coke by beehive operators of 1,165,000 tons and by by-product oven operators of 1,602,000 tons. For the last four years the sales from by-product plants have just about equaled those from beehive plants.

The most notable feature of the record for 1922 is the large increase in the sales of domestic sizes of coke. In the beehive-coke trade this increase was not great, for beehive coke is not well adapted for domestic use, the domestic market is small, and therefore few plants are equipped to crush and screen the product into sizes suitable for household use. Even the shortage of anthracite in 1922 called out but 180,000 tons of domestic sizes of beehive coke, though no doubt some of the larger coke sold ultimately found its way into the cellars of householders. But in the by-product coke industry sales of "domestic and other" coke reached the surprising total of 3,866,000 tons, equivalent to 13.5 per cent of the entire output. In comparison with 1921 this was an increase of 130 per cent, and it exceeded by a million tons the maximum reached in any preceding year. Not all of this coke was used for household fuel, however, for "domestic coke" is also sold for heating apartments, hotels, and other buildings and for a variety of industrial uses, including the manufacture of water gas, as well as for heating homes. The figure of 3,866,000 tons also includes considerable quantities of small coke furnished at special rates to employees of affiliated steel plants, which, though used for house heating and cooking, can hardly be considered an element in the commercial coke trade.

TABLE 36.—*By-product coke produced and sold or used by the producer in the United States in 1921 and 1922.*

[Exclusive of screenings and breeze.]

State.	Produced.		Sold.								Used by producer (net tons).
			Furnace.		Foundry.		Domestic and other.		Total.		
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	
1921.											
Alabama	2,401,127	$11,461,771	294,818	$1,613,161	12,954	$108,157	41,493	$182,413	349,265	$1,903,731	1,726,667
Colorado	286,755	(a)	18,137	(a)					18,137	(a)	268,739
Illinois	1,322,178	11,383,808	206,755	1,945,854	78,686	824,912	250,224	2,360,926	529,665	5,671,692	663,074
Indiana	3,091,263	19,007,519	4,180	35,890	80,110	759,481	134,082	1,051,777	218,372	1,847,148	2,684,908
Kentucky	185,383	1,097,467	113,942	600,095	40,000	308,836	29,889	180,133	183,831	1,089,064	
Maryland	292,439	(a)	102,358	(a)					102,358	(a)	124,603
Massachusetts	294,059	(a)	5,584	(a)	191,306	(a)	83,678	(a)	280,568	(a)	
Michigan	777,125	7,050,191	24,392	187,663	133,114	1,407,347	356,553	3,047,361	514,059	4,642,371	221,459
Minnesota	435,866	4,337,016	3,610	31,235	36,214	441,004	96,538	975,746	136,362	1,447,985	154,649
New Jersey	739,768	(a)	155,716	(a)	44,219	(a)	232,229	(a)	432,164	(a)	28,904
New York	746,916	5,451,865	311,093	2,403,499	9,313	70,629	64,285	628,419	384,691	3,102,547	336,280
Ohio	2,966,273	15,837,503	419,176	2,188,509	7,045	46,454	67,806	329,908	494,027	2,564,871	2,503,008
Pennsylvania	5,303,371	21,740,543	747,216	4,550,399	76	576	46,604	208,940	793,896	4,759,915	4,542,614
Tennessee	57,723	290,675	5,795	28,390	22,208	125,355	3,536	16,299	31,539	170,044	
Washington	23,765	159,938					704	4,928	704	4,928	19,667
West Virginia	188,355	845,878	56,797	255,447			11,254	52,904	68,051	308,441	109,579
Missouri, Rhode Island, and Wisconsin	637,214	6,107,201	129,649	1,225,361	81,146	905,657	261,036	2,369,352	471,831	4,500,370	86,245
Undistributed		12,735,271		2,137,491		2,664,373		2,459,969		7,261,833	
	19,749,580	117,506,646	2,593,318	17,202,994	736,391	7,662,781	1,679,911	13,809,165	5,009,620	38,674,940	13,470,336
1922.											
Alabama	3,493,656	12,972,839	64,040	321,449	265,930	1,511,173	109,906	576,988	439,876	2,409,610	3,075,709
Colorado	364,678	(a)					18,697	(a)	18,697	(a)	347,007
Illinois	1,982,906	18,164,549	106,571	869,249	156,576	1,327,201	753,724	7,910,849	1,016,871	10,107,299	1,071,098
Indiana	3,995,505	28,978,431	67,183	451,337	155,207	1,593,867	240,833	2,157,797	463,223	4,183,001	3,656,113
Kentucky	456,645	3,397,439	286,254	1,900,027	112,658	1,047,677	76,880	591,681	475,792	3,539,385	
Maryland	589,893	(a)					114,710	(a)	114,710	(a)	482,787
Massachusetts	407,081	(a)			239,943	(a)	156,532	(a)	396,475	(a)	16,843
Michigan	1,142,059	9,229,083	235,048	1,610,079	120,139	1,194,182	501,714	4,140,824	856,901	6,945,085	354,449
Minnesota	462,044	4,641,871			58,128	733,353	250,610	2,818,220	308,738	3,551,573	227,732
New Jersey	790,811	(a)	86,192	720,472	196,996	(a)	700,115	(a)	983,303	(a)	123,078
New York	1,494,992	11,865,785	210,538	2,112,480	6,997	61,401	142,230	1,330,550	359,765	3,504,431	1,158,373
Ohio	4,911,670	32,387,137	722,144	4,250,254	11,206	86,964	326,550	1,714,093	1,059,900	6,051,311	3,846,693

a Included under "Undistributed."

TABLE 36.—*By-product coke produced and sold or used by the producer in the United States in 1921 and 1922*—Continued.

State.	Produced.		Sold.								Used by producer (net tons).
			Furnace.		Foundry.		Domestic and other.		Total.		
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	
1922.											
Pennsylvania	7,151,912	$36,702,974	628,759	$4,498,506	7,053	$93,485	81,087	$463,990	716,899	$5,055,981	6,545,022
Tennessee	27,454	202,336	5,436	32,822	10,648	82,764	11,076	84,828	27,160	200,414	
Washington	5,611	44,439					1,952	20,007	1,952	20,007	5,037
West Virginia	501,894	3,074,934	278,130	1,612,775			89,014	780,488	367,144	2,393,263	149,442
Missouri, Rhode Island, and Wisconsin	771,734	7,520,701	244,629	2,257,044	260,252	2,776,419	290,121	2,757,296	795,002	7,790,759	47,440
Undistributed		19,094,249				5,412,945		9,079,443		15,212,860	
	28,550,545	188,276,767	2,934,924	20,636,494	1,601,733	15,921,431	3,865,751	34,407,054	8,402,408	70,964,979	21,106,823

TABLE 37.—*Beehive coke produced and sold or used by the producer in the United States in 1921 and 1922.*

[Exclusive of screenings and breeze.]

State.	Produced.		Sold.								Used by producer (net tons).
			Furnace.		Foundry.		Domestic and other.		Total.		
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.	
1921.											
Alabama	132, 912	$794, 314			63, 133	$411, 471			63, 133	$411, 471	69, 586
Colorado	81, 376	(a)	669	(a)	24, 078	(a)	953	(a)	25, 700	(a)	56, 358
Georgia	6, 943	80, 828			6, 943	80, 828			6, 943	80, 828	
Kentucky	99, 442	766, 240	100, 509	$753, 621					100, 509	753, 621	
Ohio	62, 150	434, 950					24	(a)	24	(a)	62, 126
Pennsylvania	4, 466, 105	22, 371, 288	3, 362, 526	16, 526, 871	758, 341	4, 093, 408	49, 455	$214, 152	4, 170, 322	20, 834, 431	275, 834
Tennessee	28, 005	168, 794	10, 406	72, 738	11, 060	63, 306			21, 466	136, 044	6, 403
Virginia	280, 476	2, 029, 652	191, 363	1, 407, 393	77, 161	527, 150			268, 524	1, 934, 543	13, 034
Washington	3, 495	34, 572	2, 544	23, 795	951	10, 777			3, 495	34, 572	
West Virginia	209, 537	1, 407, 166	127, 624	791, 441	68, 104	504, 614	2, 481	16, 795	198, 209	1, 312, 850	12, 116
New Mexico and Utah	167, 601	1, 443, 672	162, 068	1, 396, 947	1, 572	13, 121	3, 961	33, 664	167, 601	1, 443, 732	24
Undistributed		634, 973		6, 580		227, 924		7, 801		242, 305	
	5, 538, 042	30, 166, 449	3, 957, 709	20, 979, 386	1, 011, 343	5, 932, 599	56, 874	272, 412	5, 025, 926	27, 184, 397	495, 481
1922.											
Alabama	306, 209	1, 735, 406	56, 837	276, 975	64, 276	351, 241	1, 762	8, 353	122, 875	636, 569	160, 774
Colorado	119, 361	821, 309	14, 523	109, 547	14, 873	123, 832	11, 815	92, 751	41, 211	326, 130	77, 983
Georgia	8, 832	74, 807			8, 767	74, 264			8, 767	74, 264	
Kentucky	30, 522	216, 701	6, 230	46, 657					6, 230	46, 657	24, 292
New Mexico	87, 631	788, 679					1, 504	13, 532	1, 504	13, 532	86, 127
Ohio	99, 468	713, 186									104, 968
Pennsylvania	6, 839, 980	38, 091, 586	5, 355, 374	28, 697, 120	837, 654	5, 991, 486	126, 880	710, 412	6, 319, 908	35, 399, 018	486, 771
Tennessee	86, 442	618, 542	12, 393	82, 751	2, 070	13, 566			14, 463	96, 317	71, 979
Utah	172, 453	1, 406, 109	167, 377	1, 369, 972	1, 732	13, 375	3, 344	22, 762	172, 453	1, 406, 109	
Virginia	378, 656	2, 291, 336	227, 629	1, 318, 616	123, 568	779, 102	7, 987	63, 718	359, 184	2, 161, 436	19, 201
Washington	26, 063	241, 442	13, 791	129, 208					13, 791	129, 208	11, 860
West Virginia	417, 850	3, 037, 453	250, 849	1, 693, 594	111, 776	987, 534	26, 378	174, 486	389, 003	2, 855, 614	27, 931
	8, 573, 467	50, 036, 556	6, 105, 003	33, 724, 440	1, 164, 716	8, 334, 400	179, 670	1, 086, 014	7, 449, 389	43, 144, 854	1, 071, 886

(a) Included under "Undistributed."

COKE FOR HOUSEHOLD FUEL.

The shortage of anthracite in 1922 aroused much interest in substitute fuels, of which by-product coke, where available, is one of the most satisfactory. To the student of coke the demand for household use has the further interest that future expansion of the industry depends largely on the market for domestic coke.

TABLE 38.—*Commercial sales of by-product coke for household use, 1913–1922.*

[Based upon incomplete reports to the United States Coal Commission supplemented from reports of operators to the Geological Survey.]

Year.	Group I. Plants for which information covered entire period including plants built during period.		Group II. Plants for which information was lacking prior to 1918 (tons sold).	Total both groups, 1918–1922 (tons sold).
	Number of plants selling coke for household use.	Tons sold.		
1913	4	402,000	(a)	(a)
1914	7	456,000	(a)	(a)
1915	8	583,000	(a)	(a)
1916	10	783,000	(a)	(a)
1917	11	789,000	(a)	(a)
1918	15	684,000	724,000	1,408,000
1919	17	882,000	450,000	1,332,000
1920	20	1,126,000	607,000	1,733,000
1921	22	637,000	401,000	1,038,000
1922	22	1,663,000	476,000	2,139,000

[a] Data not available.

In an effort to ascertain how much of the 3,866,000 tons of "domestic and other coke" reported by retort-oven operators in 1922 was actually sold for household use, Table 38 has been compiled. This table purports to cover only commercial transactions, excluding deliveries to employees. It is based in part upon information collected but not published by the United States Coal Commission, which has been supplemented by the reports of the operators to the Geological Survey. The table indicates that the total quantity sold for household fuel in 1922 was about 2,139,000 tons. It also shows a steady increase in household consumption. The group of 22 plants from which comparable data are available produced four times as much in 1922 as in 1913, but this increase was due chiefly to the coming in of the new plants during the period. A number of the plants that were in existence in 1913 sold quite as much in that year as they did in 1922. During the war the abnormal demand of the munitions industries diverted coke from domestic to furnace and foundry use, and often this diversion was made at the express direction of the Fuel Administration. Thus the by-product plants in New England practically discontinued their domestic coke trade in 1918 and have since had to reestablish it at considerable expense.

Where coke is sold for household use in any quantity the universal practice is to screen and size it, and sometimes in the interest of closer sizing it is first crushed. The sizes most commonly made are egg and nut, though stove and pea are also prepared. The dimensions of these sizes are not uniform throughout the country, but the following will indicate the approximate limits: Egg, 2 to 2½ inches;

stove, 1⅛ to 2 inches; nut, ¾ to 1⅛ inches; pea, ½ to ¾ inch. These are the sizes reported by a New England producer. Where only two sizes are prepared, the egg commonly includes stove as given above, and the nut commonly includes pea.

These different sizes find favor for different types of furnaces and stoves. In the Middle West egg is preferred for fairly large house-heating furnaces, whether hot air, steam, or hot water. Stove is preferred by householders having relatively small furnaces or very large stoves. The nut coke is used in medium-sized and large base burners and ranges. The pea coke is used in smaller base burners and in kitchen ranges and is particularly well adapted for use in certain house-heating boilers originally designed for the use of buckwheat anthracite. Two or more sizes may be combined to good advantage—the egg, for example, to give a hot fire and the pea or nut to bank the fire at night or in warm weather. With selection of the proper size and with proper firing, coke can be burned in the great majority of household furnaces. The most serious objection to its use as compared with anthracite is the large bulk in proportion to weight. Cellar bins that formerly carried a winter's supply of anthracite will accommodate only two-thirds of a winter's supply of coke; furnaces that are large enough to carry an all-night supply of anthracite may be too small to carry a coke fire as long as the householder wishes. These disadvantages are largely offset by the quicker response that the coke fire gives to the drafts and the smaller percentage of ash that it contains.

The ash content is reported by the companies selling by-product coke for household use as 6 to 15 per cent, the figures most commonly reported being about 10 or 12 per cent. Not only is the ash content low, but the percentage of fixed carbon that is lost in the ash is smaller than with raw coal, because of more perfect combustion.

To introduce coke in competition with domestic anthracite in ordinary times it must be offered at a price somewhat less than the anthracite. The experience of the companies reporting indicates that a difference of $1 to $2 a ton must be allowed, and one producer reports that on the small sizes during the summer a difference of $3 is necessary.

The distribution of domestic by-product coke is largely managed without the aid of wholesalers. The foundry-coke business is generally handled by jobbers, who also deal in pig iron and other foundry supplies. This arrangement was established long ago, when Connellsville coke was the standard in the foundry trade, and by-product coke operators have in consequence commonly marketed their foundry coke through the channels they found in existence. Wholesalers, however, handle only a small percentage of the by-product coke sold for household use. They may be called on occasionally by steel plants to market an excess of fine coke, and they are engaged by certain of the merchant plants in West Virginia, Tennessee, and southern Ohio to place domestic coke in the cities of the North. These exceptions serve but to prove the rule that the burden of creating a market for household coke has fallen directly on the coke producer himself. The typical merchant coke plant located near a large northern city sells part of its domestic coke direct to householders and places the remainder through retailers. Its market is a distinctly local one, in the vicinity of the city where the coke is made. Within this local

area each company has sought to develop its own market by ways more or less ingenious. Advertising, personal solicitation, demonstration, distribution of sample bags, and canvassing by mail and telephone have all been tried. There has been no national association of coke producers nor any concerted effort to broaden the market.

There remain, therefore, many cities of the North in which by-product coke is seldom offered for sale, and the market is far from saturated. The suggestion has been made that the producers should unite in a general sales campaign to increase the demand for coke in the territory north of the Ohio and Potomac and east of the Mississippi, and such a campaign would probably increase business.

The need of such cooperative action by the producers of coke is illustrated by the bad impression made upon the public by the high prices at which household coke was sold in all too many cities during the winter of 1922–23. The opportunity of a lifetime to introduce coke into new markets was thus largely sacrificed. The high prices were not directly attributable to the producers, who seem to have sold their coke in the vicinity of their works on about the usual terms. This statement is proved by their average receipts from sales of domestic by-product coke during the last three years, which were as follows: 1920, $8.93 a ton; 1921, $8.22; 1922, $8.90. The average receipts f. o. b. plant in 1922 were thus only 68 cents a ton higher than in 1921 and were slightly lower than in 1920. The producer, however, had little influence on the price at which his coke reached the consumer except in the immediate vicinity of his plant. In other communities the householder found too often that he could buy the substitute coke only at prices as high as anthracite itself, and his experience served but to confirm him in the anthracite habit. The experience is believed to indicate the need of cooperative effort among producers to widen the demand for coke and to insure its sale in times of shortage at prices that will indicate to the consumer the terms on which it may be procured in normal times.

In view of the stationary production of anthracite and the increase in anthracite prices in recent years, there is need to educate consumers in the use of substitute fuel and to determine by experiment the best types of substitutes and the best methods of utilizing them. Attention should be directed to the improvement of heating appliances with a view to utilizing the available substitutes more fully. If the price of by-product coke can be kept $1 or $2 below the retail price of anthracite, steady growth in its consumption for household purposes may be confidently expected.

STOCKS OF COKE AT END OF YEAR.

The expense attendant on closing down by-product ovens and firing them again and the heavy overhead costs of idle time often lead by-product operators to produce coke for stock. Particularly is this likely to happen where the company is under contract to supply gas for municipal use. During the depression of 1921 very large quantities of unsold coke accumulated. On the 1st of January, 1922, at a group of 21 plants that sell coke for domestic purposes, the stock on hand, including furnace and foundry grades, amounted to 1,017,000 net tons. By the end of the year the stocks of the same plants had dropped 212,000 tons. (See fig. 33 and Table 39.)

TABLE 39.—*Stocks of unsold coke at 21 by-product coke plants supplying gas for city use, 1922–23, in net tons.*

January 1, 1922	1,017,000	June 1, 1923	202,000
March 1, 1922	987,000	July 1, 1923	308,000
October 1, 1922	250,000	August 1, 1923	429,000
November 1, 1922	228,000	September 1, 1923	501,000
January 1, 1923	212,000	October 1, 1923	476,000
February 1, 1923	146,000	December 1, 1923	772,000
March 1, 1923	92,000		

So serious to the by-product operator was the problem of disposing of this coke that the Geological Survey deemed it advisable to add to its annual schedule for 1922 an inquiry on this subject, the result of which is summarized in Table 40. Stocks of furnace coke on December 31, 1922, were 706,598 tons. More than half of this quantity was in the State of Alabama. Stocks of foundry coke were much smaller, only 22,542 tons, and the quantity of breeze on hand was 157,342 tons. The table does not include stocks of domestic coke, but in view of the active demand for domestic by-product coke as a substitute for anthracite during the strike of 1922 such stocks were probably small.

In the operation of beehive ovens, on the other hand, there is seldom cause to accumulate large stocks, and at the end of 1922 the quantity on hand at beehive works was 88,943 tons of furnace coke and 3,598 tons of foundry coke. This was equivalent to the product of about 1½ days.

TABLE 40.—*Stocks of furnace and foundry coke and of breeze at the end of 1922, by States, in net tons.*

State.	Furnace.	Foundry.	Breeze.
By-product plants.			
Alabama	487,039	394	64,962
Colorado	1,823		848
Illinois	8,617	474	12,449
Indiana	14,228	249	12,075
Kentucky	1,037	405	329
Maryland	6,033		
Massachusetts		6,983	10,569
Michigan	1,441	6,925	5,101
Minnesota	98,371		7,505
New Jersey	2,950		150
New York	20,658		13,983
Ohio	30,472	295	14,984
Pennsylvania	21,940		7,771
Tennessee	102	192	614
Washington	4,153		
West Virginia	1,871		273
Missouri, Rhode Island, and Wisconsin	5,863	6,625	5,729
	706,598	22,542	157,342
Beehive plants.			
Alabama	38,359	983	
Colorado	182		
Georgia		65	
New Mexico	821		
Ohio	5,500		
Pennsylvania	38,195	2,169	8,862
Tennessee	2,167	103	25
Virginia	1,808	178	
Washington	412		
West Virginia	1,499	100	
	88,943	3,598	8,887

COKE CONSUMED IN THE MANUFACTURE OF PIG IRON.

The quantity of coke consumed in the manufacture of pig iron in 1922, according to the American Iron and Steel Institute, was 29,213,000 net tons, or 77.0 per cent of the total production of beehive and by-product coke. Table 41, which shows the consumption of coke in iron manufacture for the last ten years, brings out a noteworthy improvement in efficiency of fuel utilization. The quantity of coke required to make a gross ton of pig iron declined from an

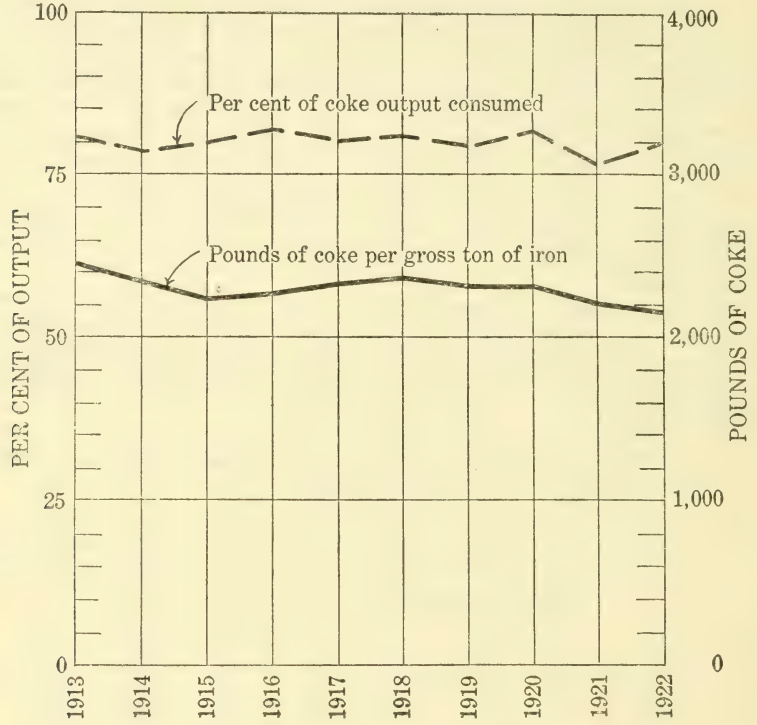


FIGURE 45.—Trends in blast-furnace consumption of coke, 1913–1922.

The manufacture of pig iron consumes about 80 per cent of the total quantity of coke with surprising regularity. The quantity of coke consumed per gross ton of iron produced has been declining since 1918.

average of 2,433.3 pounds in 1913 to 2,176.3 pounds in 1922. Among the factors contributing to this gratifying result are increased efficiency in the operation of the blast furnace, replacement of old with new furnaces, and, not least important, improvement in the quality of coke manufactured, an improvement directly correlated with the substitution of by-product for beehive coke.

TABLE 41.—*Coke consumed in the manufacture of pig iron, 1913–1922.*

[From annual report of the American Iron and Steel Institute.]

Year.	Coke consumed.		Pig iron produced[a] (gross tons).
	Net tons.	Pounds per gross ton of pig iron produced.	
1913	37, 192, 287	2, 433. 3	30, 326, 130
1914	27, 070, 856	2, 354. 4	22, 976, 856
1915	33, 224, 328	2, 252. 0	29, 535, 308
1916	44, 431, 905	2, 285. 3	38, 844, 598
1917	44, 493, 316	2, 339. 7	37, 863, 643
1918	45, 708, 594	2, 375. 2	38, 422, 175
1919	35, 250, 943	2, 310. 2	30, 549, 930
1920	41, 976, 171	2, 305. 6	36, 300, 024
1921	18, 162, 147	2, 200. 6	16, 579, 653
1922	29, 213, 893	2, 176. 3	26, 995, 173

[a] Excludes pig iron made with anthracite and charcoal but includes small quantities made with electricity and bituminous coal.

GEOGRAPHIC DISTRIBUTION OF COKE CONSUMPTION.

The close association of coke consumption with the metallurgical industries is the outstanding feature of the map showing consumption of coke by States and districts (Pl. VI). This map is based upon information compiled by the census of manufactures and the census of mines and quarries, 1919. It includes all the coke consumed by manufacturing and mining industries and public utilities, whether beehive, by-product, gas-house, or petroleum coke. It does not show domestic coke burned in heating dwellings, hotels, apartments, and the like, which amounted to perhaps 2,000,000 tons in 1919.

The map is essentially a composite picture of the activities of the blast-furnace, smelting, and foundry industries. The great centers of pig-iron production stand clearly revealed. Pittsburgh and the adjacent districts, eastern Pennsylvania, the Mahoning and Shenango valleys, Cleveland and other centers of Ohio, Buffalo, Baltimore, Birmingham, Chicago, and the western outposts of Duluth and Colorado are all now equipped with by-product plants to supply at least part of the coke needed. The scattered iron-producing districts of Virginia and Tennessee, on the other hand, are still dependent on beehive coke.

West of the Mississippi, except for the iron furnaces centering around Pueblo, Colo., the large consumers of coke are the copper, lead, and zinc smelters. The copper-reduction plants of the southern Rocky Mountains are indicated, although the magnitude of their fuel consumption is not justly represented by coke alone, on account of the large quantities of fuel oil they consume. San Francisco, Shasta County, Salt Lake, Durango, Ouray, Leadville, Butte, the Coeur d'Alene, Seattle, Perth Amboy, St. Louis, Omaha, Joplin, El Paso, Ducktown, and other centers may be located by their consumption of coke. In most of these localities it is beehive coke that is used. In the zinc-producing area of Missouri, Kansas, Oklahoma, and Arkansas a small consumption of fine coke is reported.

The showing of consumption at some unexpected points in eastern Texas and Louisiana is puzzling until it is remembered that the census records include petroleum coke. Some of the dots in this quarter of the map represent petroleum refineries that consume their own coke as boiler fuel. The same factor contributes to the density of consumption in the States of the North and East.

Again, many of the dots stand for the consumption of gas-house coke, used by associated water-gas units. This fact adds to the density of the showing for many of the large cities.

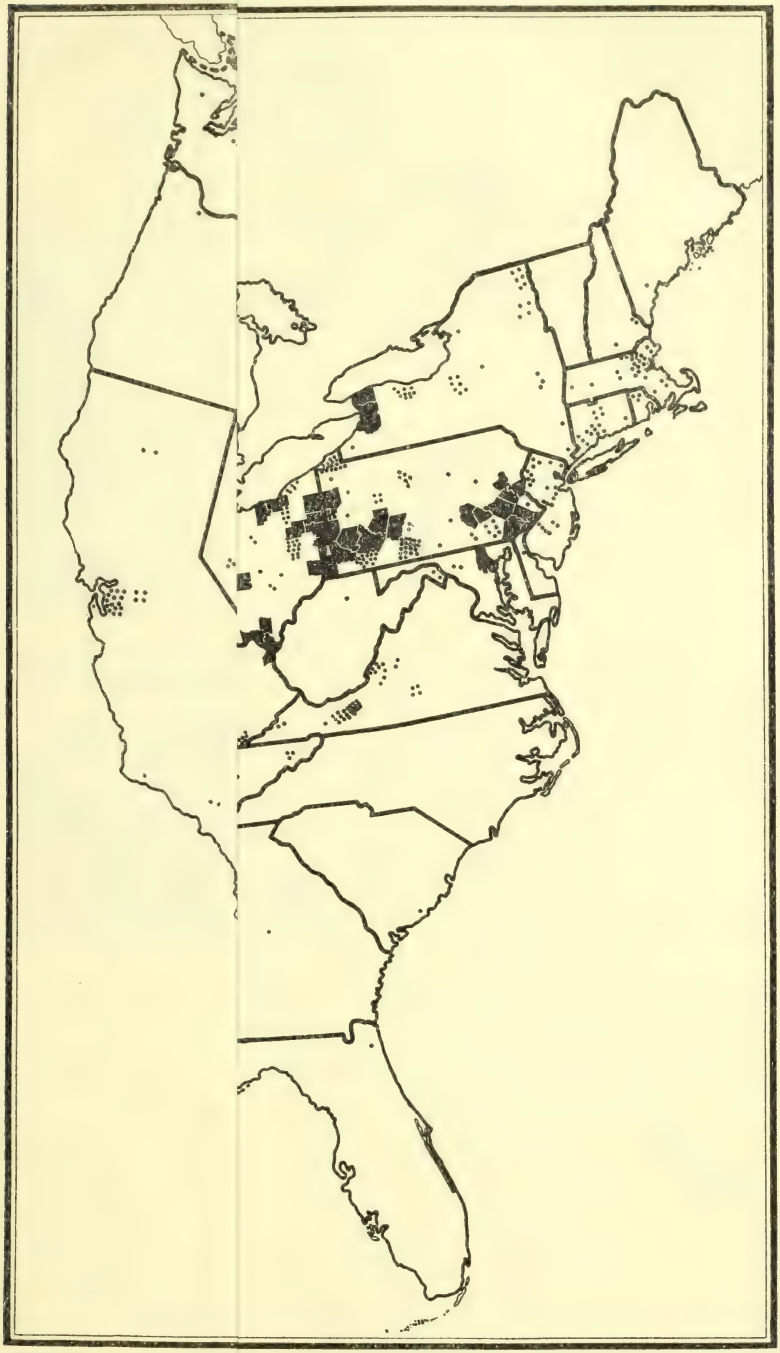
The market for foundry coke is chiefly the industrial region north of the Ohio and Potomac and east of the Mississippi, together with the St. Louis and Birmingham districts. In order of amount consumed the leading States are Pennsylvania, New York, Ohio, Illinois, Alabama, Michigan, and New England.

VALUE.

The term "value," as applied to coke in the reports of the Geological Survey, means the value at the ovens. For that part of the output that is sold the value is obviously the amount received for the coke f. o. b. ovens. But a considerable proportion of the coke produced in the United States is made in ovens operated by large corporations that not only mine the coal and make the coke but also operate blast furnaces and steel mills that consume the entire product of the ovens. Under such conditions the fixing of a value upon the coke and upon the coal consumed in making it is purely arbitrary. By some corporations the coke is charged to the furnace department at cost; by others a percentage of profit is added or the reported value is based on what the coke would cost if purchased.

In the statistics published by the Geological Survey the value assigned to that part of the output produced but not sold has not always been arrived at in the same way, and therefore the figures of total value of all coke produced are not strictly comparable from year to year. Prior to 1918 each operator was asked to place his own value on his entire production, including coke used at the plant but not sold. In 1918 and again in 1920 the value of this part of the product was estimated by the Geological Survey by assigning to the coke produced but not sold in each State a value per ton equal to the average receipts for the coke sold in the same State. In 1919 and again in 1921 and 1922 the Survey asked the operator to place his own value on the coke used but not sold. These changes in the form of inquiry must be borne in mind in considering Tables 3 and 36.

The total value of all the coke produced, measured in this way, increased from $148,000,000 in 1921 to $238,000,000 in 1922, an increase of 61.4 per cent (Table 42). Pennsylvania leads all other States in the value of product, as in tonnage produced, and more than a third of the total value in 1922 was contributed by that State alone.



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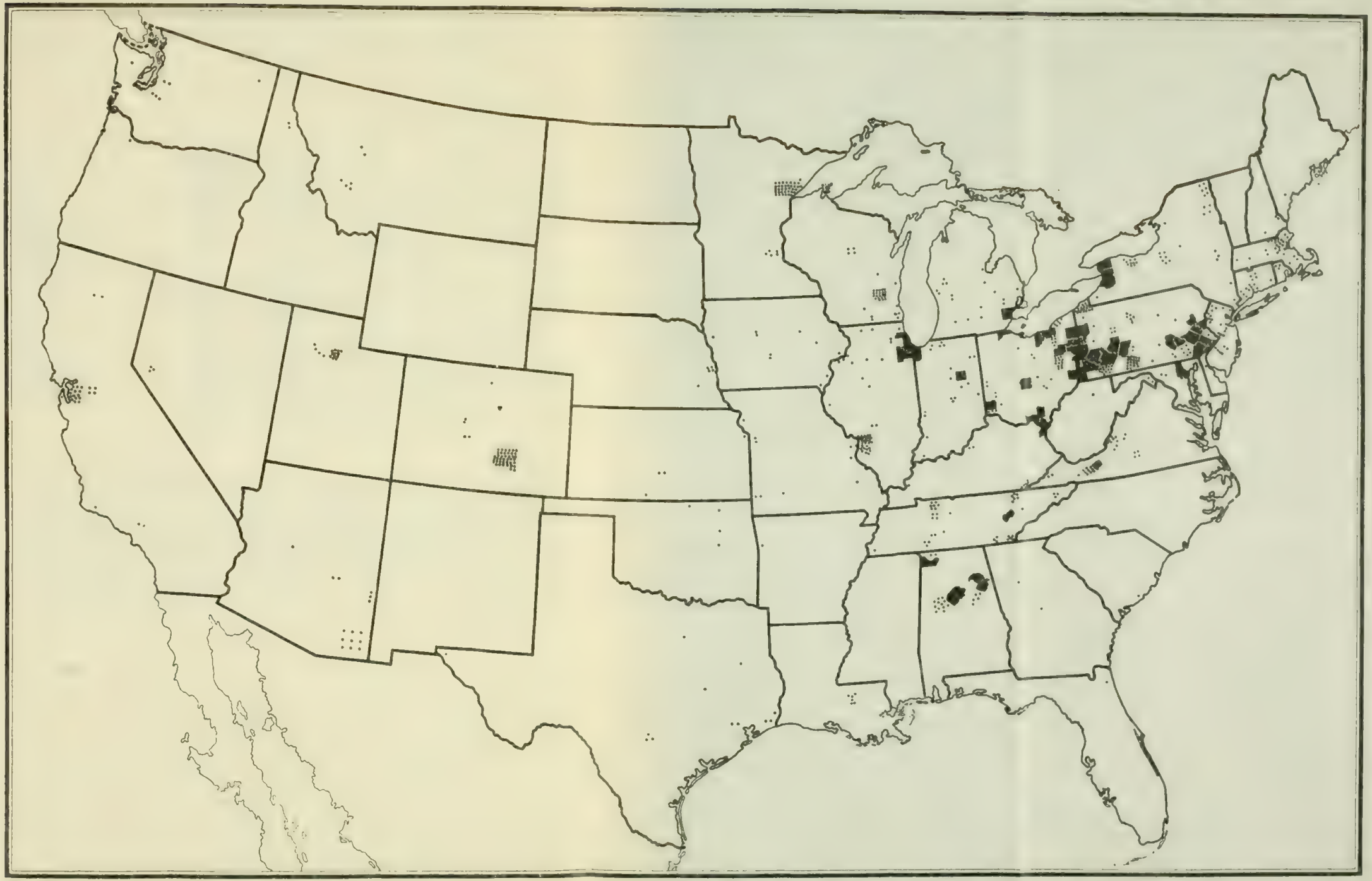

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COKE CONSUMED IN EACH COUNTY IN MANUFACTURING, SMELTING, AND MINING IN THE UNITED STATES, 1919.

Each dot represents 10,000 net tons. Map accounts for consumption of 42,648,814 tons in all. Data from Bureau of the Census

TABLE 42.—*Value of coke produced in the United States, 1921–22.*

[Exclusive of screenings and breeze.]

State.	1921	1922	Increase or decrease, 1922.			
			Total.	Percentage.		
				Total.	Beehive.	By-product.
Alabama	$12,256,085	$14,708,245	+$2,452,160	+20.0	+118.5	+13.2
Colorado	3,086,728	3,352,174	+265,446	+8.6	+29.3	+3.2
Georgia	80,828	74,807	−6,021	−7.4	−7.4	
Illinois	11,383,808	18,164,549	+6,780,741	+59.6		+59.6
Indiana	19,007,519	28,978,431	+9,970,912	+52.5		+52.5
Kentucky	1,863,707	3,614,140	+1,750,433	+93.9	−71.7	+209.6
Maryland	2,047,073	3,981,778	+1,934,705	+94.5		+94.5
Massachusetts	(a)	(a)	(a)	(a)		(a)
Michigan	7,050,191	9,229,083	+2,178,892	+30.9		+30.9
Minnesota	4,337,016	4,641,871	+304,855	+7.0		+7.0
Missouri	(a)	(a)	(a)	(a)		(a)
New Jersey	(a)	(a)	(a)	(a)		(a)
New Mexico	(a)	788,679	(a)	(a)	(a)	
New York	5,451,865	11,865,785	+6,413,920	+117.6		+117.6
Ohio	16,272,453	33,100,323	+16,827,870	+103.4	+64.0	+104.5
Pennsylvania	44,111,831	74,794,560	+30,682,729	+69.6	+70.3	+68.8
Rhode Island	(a)	(a)	(a)	(a)		(a)
Tennessee	459,469	820,878	+361,409	+78.7	+266.4	−30.4
Utah	(a)	1,406,109	(a)	(a)	(a)	
Virginia	2,029,652	2,291,336	+261,684	+12.9	+12.9	
Washington	194,510	285,881	+91,371	+47.0	+598.4	−72.2
West Virginia	2,253,044	6,112,387	+3,859,343	+171.3	+115.9	−263.5
Wisconsin	(a)	(a)	(a)	(a)		(a)
Combined States	15,787,316	20,102,307	+6,509,779	+41.2	+52.0	+23.1
	147,673,095	238,313,323	+90,640,228	+61.4	+65.9	+60.2

[a] Included under "Combined States."

The average receipts from sales represent the receipts f. o. b. ovens and do not include transportation charges. They vary notably with the distance from the mines (Table 43). Thus the highest average receipts are those reported for Minnesota, where the coal must be hauled by rail, lake, and rail from the Appalachians, or by even longer all-rail routes. The average receipts for domestic coke range somewhere between the average for furnace coke and the average for foundry coke.

TABLE 43.—*Average receipts per ton for coke sold in the United States in 1921 and 1922.*

State.	Beehive.			By-product.		
	Furnace.	Foundry.	Domestic.	Furnace.	Foundry.	Domestic.
1921.						
Alabama		$6.52		$5.47	$8.35	$4.40
Colorado	$9.83	9.46	$7.92	[a]		
Georgia		11.64				
Illinois				9.69	10.48	9.20
Indiana				8.59	9.48	7.84
Kentucky	7.50			5.27	7.72	6.03
Maryland				[a]		
Massachusetts				[a]	[a]	[a]
Michigan				7.69	10.56	8.55
Minnesota				8.65	12.18	10.11
Missouri				[a]	[a]	[a]
New Jersey				[a]	[a]	[a]
New Mexico	[a]		[a]			
New York				7.73	7.58	9.78
Ohio			[a]	5.22	6.59	4.87
Pennsylvania	4.91	5.40	4.33	6.09	7.58	4.48
Rhode Island						[a]
Tennessee	6.99	5.72		4.90	5.64	4.61
Utah	[a]	[a]	[a]			
Virginia	7.35	6.83				
Washington	[a]	[a]				7.00
West Virginia	6.20	7.41	6.76	4.50		4.71
Wisconsin				[a]	[a]	[a]
Combined States	8.63	9.47	8.51	8.16	11.27	8.37
	5.30	5.87	4.79	6.63	10.41	8.22
1922.						
Alabama	4.87	4.87	4.74	5.02	5.68	5.25
Colorado	7.54	8.32	7.85			[a]
Georgia		8.46				
Illinois				8.15	8.47	10.50
Indiana				6.72	10.27	8.88
Kentucky	7.49			6.64	9.30	7.69
Maryland						[a]
Massachusetts					[a]	[a]
Michigan				6.85	9.94	8.25
Minnesota					12.62	11.24
Missouri				[a]	[a]	[a]
New Jersey				[a]	[a]	[a]
New Mexico			9.00			
New York				10.03	8.77	9.35
Ohio				5.88	7.76	5.25
Pennsylvania	5.36	7.15	5.60	7.15	[b] 13.25	5.72
Rhode Island					[a]	
Tennessee	6.68	6.55		6.04	7.77	7.65
Utah	8.18	7.72	6.81			
Virginia	5.79	6.33	7.98			
Washington	9.37					10.25
West Virginia	6.75	8.84	6.61	5.80		8.77
Wisconsin				[a]	[a]	[a]
Combined States				9.00	10.31	9.25
	5.52	7.15	6.04	7.03	9.94	8.90

[a] Included under "Combined States."
[b] Only 7,053 tons of by-product foundry coke was sold in this State.

The course of the average value per ton during the last 10 years is shown in Table 44. From an average of $2.39 in 1913 the value of beehive coke rose to a maximum of $7.94 in 1920, fell to $5.45 during the depression of 1921, and rose again to $5.84 in 1922. In like manner the average value of by-product coke at the ovens rose from $3.83 in 1913 to $10.15 in 1920 and after a temporary drop in 1921 stood at $6.59 in 1922.

Because of the uncertainties attending the statements of value for that part of the product used by the producer but not sold, already referred to, a better index of changes in the market is provided by

the average receipts per ton of coke sold. This figure, for which no record is available prior to 1918, is shown in the right half of the table.

The average receipts from sales of by-product coke in 1922 were $8.45 a ton, an increase of 73 cents over the average for the preceding year. The average for beehive coke rose from $5.41 in 1921 to $5.79 in 1922.

TABLE 44.—*Average value per ton of all coke produced, 1913–1922, and average receipts per ton from coke sold, 1918–1922.*

Year.	Value per ton produced.[a]			Receipts per ton sold.		
	Beehive.	By-product.	Total.	Beehive.	By-product.	Total.
1913	$2.39	$3.83	$2.78	[b]	[b]	[b]
1914	2.15	3.39	2.56	[b]	[b]	[b]
1915	2.07	3.45	2.54	[b]	[b]	[b]
1916	2.69	3.95	3.13	[b]	[b]	[b]
1917	4.81	6.18	5.36	[b]	[b]	[b]
1918	6.21	7.42	6.77	$6.08	$7.88	$6.52
1919	5.15	6.37	5.85	5.05	6.58	5.60
1920	[c] 7.94	10.15	[c] 9.27	7.43	10.77	8.50
1921	5.45	5.95	5.84	5.41	7.72	6.56
1922	5.84	6.59	6.42	5.79	8.45	7.19

[a] Includes operators' statement of the value of coke consumed by them in associated enterprises, but not sold, except that in 1918 and 1920 the value of such coke was estimated by the Geological Survey for each State at the average value for that State of the part of the product reported sold.

[b] Data not available.

[c] Revised from preceding report.

Figure 46 shows graphically the course of the average value per ton of all coke produced since 1880.

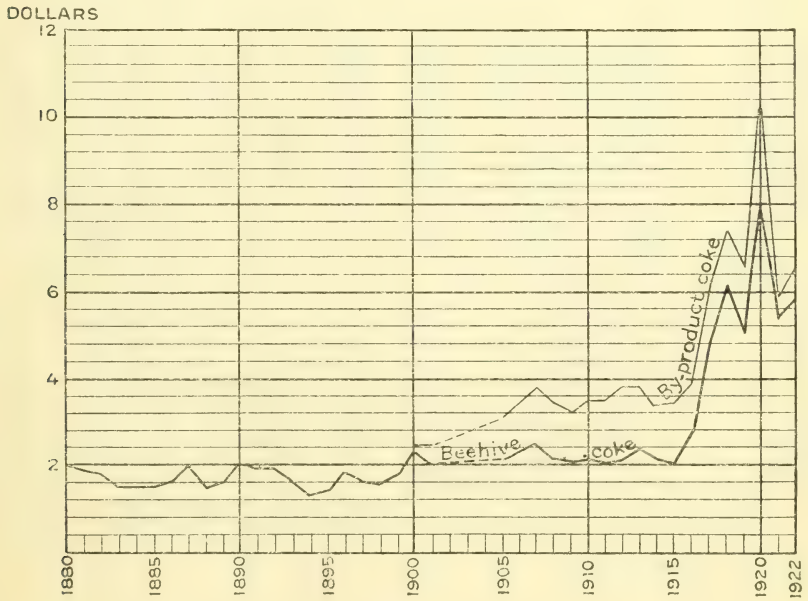

FIGURE 46.—Average value of coke at ovens, 1880–1922.

SPOT PRICES OF CONNELLSVILLE COKE.

Because the average sales receipts comprise sales on contracts or transfers to affiliated companies, sometimes at nominal prices, they do not reveal the extreme variations in the price of coke in the open market. Table 45 and Figure 47 show the average monthly prices for spot or prompt furnace and foundry coke f. o. b. ovens in the Connellsville district.

Connellsville prices have long been regarded as basic reference prices for the entire industry. The high point reached by the price of furnace coke in 1922 was $12.80 a ton, the average for August. The shortage created by the strike of 1922 thus drove spot prices nearly as high as the maximum reached in 1917, when $13.60 was recorded. The month of August, 1920, still holds the record for the highest prices of all times, with an average of $17.75.

Prices of foundry coke have ranged approximately $1 a ton higher than those of furnace coke. Only a small tonnage, it should be remembered, actually moves at these extreme prices. The greater part of the output, even of the merchant producers, is sold under contract or other arrangements of long standing at much lower prices. Thus, though the average spot price for the year 1922 was $7.06 a ton for furnace coke and $8 for foundry coke, the average value of all coke produced in the Connellsville region, according to the operators' reports to the Geological Survey, was only $5.22. (See Table 15.)

TABLE 45.—*Average monthly prices per net ton at ovens of spot or prompt Connellsville furnace and foundry coke, 1903–1922.*[a]

Month.	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Furnace.										
January	$5.00	$1.60	$2.46	$2.62	$3.53	$1.92	$1.59	$2.55	$1.40	$1.82
February	5.00	1.52	2.56	2.14	3.50	1.86	1.59	2.12	1.45	1.78
March	5.00	1.65	2.43	2.24	3.02	1.72	1.60	2.00	1.55	2.12
April	4.20	1.60	2.07	2.45	2.72	1.57	1.60	1.77	1.59	2.39
May	3.50	1.50	1.87	2.46	2.16	1.50	1.57	1.66	1.50	2.28
June	3.00	1.45	1.82	2.32	1.89	1.55	1.52	1.65	1.42	2.02
July	2.50	1.45	1.81	2.51	2.40	1.57	1.58	1.59	1.44	2.21
August	2.25	1.45	1.80	2.76	2.62	1.50	1.66	1.57	1.46	2.21
September	2.20	1.45	2.10	2.85	2.82	1.50	2.39	1.60	1.50	2.37
October	1.90	1.47	2.61	2.84	2.85	1.53	2.76	1.59	1.50	3.41
November	1.75	2.04	2.95	3.13	2.41	1.72	2.74	1.50	1.52	3.94
December	1.62	2.12	2.79	3.52	2.06	1.82	2.67	1.44	1.60	4.00
Average	3.16	1.61	2.27	2.65	2.67	1.65	1.94	1.75	1.49	2.55
Foundry.										
January	6.50	2.18	2.38	3.42	4.25	2.45	2.00	2.90	1.90	1.97
February	6.50	2.10	2.68	2.65	4.00	2.39	1.95	2.70	2.10	2.09
March	6.50	2.25	2.75	2.78	3.65	2.25	1.95	2.60	2.05	2.56
April	5.50	2.15	2.70	2.95	3.31	2.22	1.86	2.45	2.00	2.69
May	4.50	2.00	2.55	2.81	3.00	2.03	1.85	2.20	1.81	2.58
June	3.50	1.90	2.40	2.65	3.00	2.00	1.80	2.17	1.76	2.40
July	3.25	1.80	2.35	2.79	3.00	2.00	2.00	2.15	1.82	2.40
August	3.00	1.75	2.25	3.00	3.08	1.92	1.95	2.15	1.85	2.40
September	2.87	1.85	2.50	3.19	3.20	1.90	2.55	2.12	1.85	2.54
October	2.87	2.00	3.00	3.31	3.25	2.10	2.90	2.10	1.81	3.65
November	2.50	2.25	3.50	4.00	2.75	2.20	3.25	2.05	1.85	4.25
December	2.25	2.35	3.50	4.12	2.50	2.25	3.20	1.97	1.90	4.50
Average	4.15	2.05	2.71	3.14	3.25	2.14	2.27	2.30	1.89	2.84

[a] Iron Age, January 3, 1924, p. 85.

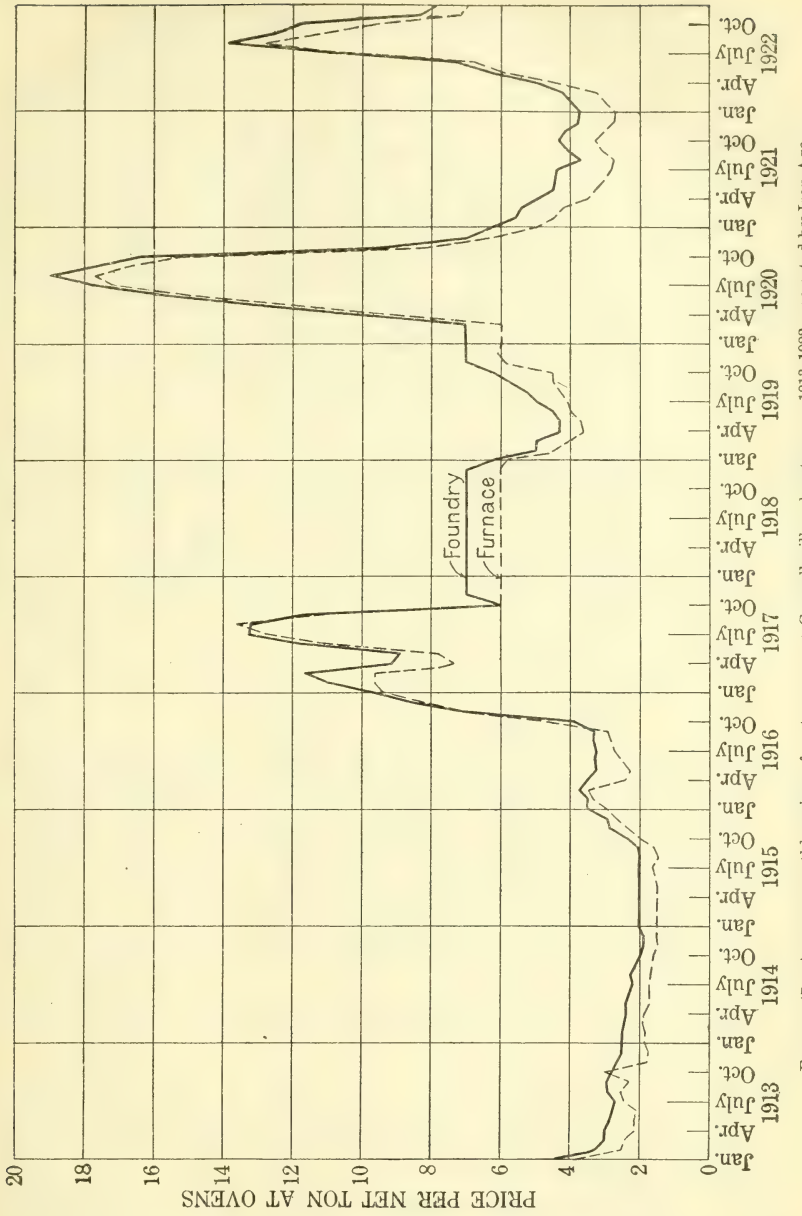

FIGURE 47.—Average monthly prices of spot or prompt Connellsville coke at ovens, 1913–1922, as quoted by Iron Age.

TABLE 45.—*Average monthly prices per net ton at ovens of spot or prompt Connellsville furnace and foundry coke, 1903–1922*—Continued.

Month.	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Furnace.										
January	$3.88	$1.85	$1.50	$2.94	$9.50	$6.00	$5.65	$6.00	$5.06	$2.75
February	2.52	1.85	1.50	3.38	9.62	6.00	4.44	6.00	4.50	3.04
March	2.40	1.90	1.50	3.47	9.60	6.00	4.06	6.00	4.35	3.25
April	2.15	1.86	1.50	2.41	7.38	6.00	3.65	9.60	3.50	4.48
May	2.13	1.77	1.50	2.30	7.80	6.00	3.69	12.00	3.25	6.00
June	2.11	1.75	1.56	2.49	11.25	6.00	4.00	15.00	3.00	6.75
July	2.45	1.75	1.64	2.75	12.75	6.00	4.07	17.20	2.81	10.75
August	2.50	1.70	1.50	2.80	13.60	6.00	4.31	17.75	2.75	12.80
September	2.29	1.65	1.61	2.94	11.12	6.00	4.56	16.70	3.15	11.13
October	2.98	1.60	2.03	4.88	6.00	6.00	4.52	15.12	3.28	9.60
November	1.82	1.52	2.28	6.90	6.00	6.00	5.87	8.26	3.03	7.19
December	1.75	1.50	2.64	8.38	6.00	6.00	6.12	6.20	2.75	7.00
Average	2.42	1.73	1.73	3.80	9.22	6.00	4.58	11.32	3.45	7.06
Foundry.										
January	4.40	2.50	2.00	3.50	9.75	7.00	6.25	7.00	6.38	3.75
February	3.25	2.50	2.00	3.50	11.00	7.00	5.00	7.00	5.63	4.00
March	3.00	2.45	2.00	3.75	11.60	7.00	4.94	7.00	5.45	4.25
April	3.00	2.40	2.00	3.56	9.13	7.00	4.30	10.20	4.75	5.06
May	2.85	2.40	2.00	3.25	8.90	7.00	4.31	13.00	4.50	6.30
June	2.80	2.32	2.00	3.25	11.72	7.00	4.56	15.75	4.45	7.25
July	2.70	2.22	2.05	3.25	13.25	7.00	5.00	17.80	4.06	11.00
August	2.90	2.25	2.00	3.30	13.20	7.00	5.25	18.88	3.75	13.90
September	2.90	2.10	2.07	3.31	11.75	7.00	5.80	17.70	4.15	12.50
October	2.81	2.00	2.35	3.88	6.00	7.00	6.25	16.38	4.38	11.70
November	2.60	1.92	2.88	7.10	7.00	7.00	7.00	9.50	4.19	8.38
December	2.50	1.90	2.95	8.63	7.00	7.00	7.00	7.00	3.81	7.88
Average	2.98	2.25	2.19	4.19	10.03	7.00	5.47	12.27	4.63	8.00

IMPORTS AND EXPORTS.

The coal strike of 1922 operated to curtail exports and stimulate imports of coke. The exports, 511,541 net tons, though larger than during the year of depression, 1921, were barely a third of those in 1918 and only about half of those before the war. As usual, the principal export movement was to the central provinces of Canada through the Buffalo and Detroit gateways. Shipments to northern Mexico through the customs districts of Arizona, San Antonio, and El Paso, which averaged a third of a million tons annually when the lead and copper smelters of northern Mexico were active, shrank in 1922 to 34,000 tons. Sea-borne exports, never important in the total distribution of coke, also fell off sharply in comparison with 1920.

Imports of coke, on the other hand, were the largest since 1914, though still but 0.25 per cent of the domestic production. Practically all the coke imported was of British origin, and three-fourths of it came from England, which normally can not compete in the American market.

The statistics of imports and exports given in Tables 46 to 52 are compiled from the records of the Bureau of Foreign and Domestic Commerce.

TABLE 46.—*Coke exported from the United States, 1909–1922.*

Year.	Net tons.	Value.	Year.	Net tons.	Value.
1909	1,002,916	$3,232,673	1916	1,174,645	$4,202,236
1910	984,618	3,053,293	1917	1,409,320	8,543,746
1911	1,023,727	3,215,990	1918	1,687,824	11,861,408
1912	912,576	3,002,742	1919	716,956	5,128,119
1913	987,395	3,309,930	1920	919,802	9,993,665
1914	663,585	2,233,686	1921	306,755	2,760,939
1915	895,509	3,092,498	1922	511,541	4,319,538

TABLE 47.—*Coke exported from the United States, 1920–1922, by customs districts.*

District.	1920		1921		1922	
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.
Arizona	95,991	$765,120	186	$2,571	25,873	$211,436
Buffalo	312,359	3,080,027	105,378	940,539	206,995	1,519,685
Dakota	4,726	63,140	8,072	70,560	28,344	282,050
Duluth-Superior	4,980	56,638	1,455	14,945	3,359	33,288
El Paso	68,496	403,956	6,067	43,781	4,135	40,415
Florida	4,501	79,942	5,226	89,260	3,328	40,190
Galveston			46	581	48	995
Georgia			225	3,492	782	9,500
Maine and New Hampshire	1,602	24,737	345	2,282	2,762	25,342
Maryland	78,889	842,558	20,315	127,050	15,943	95,310
Michigan	224,623	2,801,026	86,905	757,439	145,013	1,310,144
Mobile	239	5,538	151	2,397	10,408	70,967
New Orleans	786	19,278	1,755	33,762	11,185	155,152
New York	38,884	702,379	7,710	124,288	7,184	100,332
Ohio	18,450	178,178	6,140	37,280	3,760	35,971
Philadelphia	28,139	522,312	13,321	128,354	16,215	145,658
Porto Rico	66	1,294	4	94	24	438
Rochester	3,603	45,605	998	9,988	274	2,534
Sabine	381	5,602	246	1,845	27	333
St. Lawrence	19,573	166,994	16,570	120,100	10,078	108,061
San Antonio	4,294	75,677	19,204	159,585	3,308	14,661
San Diego	4	70	3	63	1	30
San Francisco	1,562	22,958	391	9,456	157	3,973
South Carolina	38	348			714	2,898
Vermont	2,691	33,353	1,734	13,596	9,042	89,674
Virginia	3,386	78,732	4,181	66,463	2,272	17,255
Washington	1,539	18,209	127	1,168	310	3,246
	919,802	9,993,665	306,755	2,760,939	511,541	4,319,538

TABLE 48.—*Coke exported from the United States, 1920–1922, by countries of destination.*

Destination.	1920		1921		1922	
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.
Argentina	4,943	$110,935	2,219	$43,123		
Barbados			17	185		
Belgium	16,323	307,826	2,256	24,648	224	$2,285
Bermuda	9	153	3	70	3	47
Brazil	2,479	48,363	833	11,731	4	62
British Honduras	6	137	8	138	7	122
British West Africa	134	4,240	22	426		
Bulgaria	622	18,315				
Canada	594,143	6,467,875	227,641	1,967,108	410,828	3,416,769
Chile	56,785	574,234	5,572	34,601	11,975	75,126
Colombia	133	3,386	157	3,402	105	2,578
Costa Rica	91	2,316	67	1,278	67	1,446
Cuba	6,880	132,232	7,026	110,736	5,387	52,642
Denmark	7,820	141,670				
Dominican Republic	276	6,623	99	1,995	73	1,326
Dutch East Indies	473	10,003				
Ecuador	108	2,737	71	1,309	34	803

TABLE 48.—*Coke exported from the United States, 1920–1922, by countries of destination*—Continued.

Destination.	1920		1921		1922	
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.
Egypt	56	$1,250				
England	312	5,700	99	$920	631	$6,500
Finland	5,659	107,393				
France	15,346	252,608	2,880	40,100	8,641	112,698
French Oceania			2	49	7	132
French West Indies	32	866	7	136		
Germany			3,333	30,874	5,459	58,682
Greece	392	7,450				
Guatemala	56	1,401	84	1,538	34	541
Haiti			2	40		
Honduras	43	798	38	620	36	647
Italy	840	14,400	560	4,000	4,754	46,921
Jamaica			36	614	1,195	8,336
Mexico	171,161	1,281,857	31,232	262,167	34,390	283,565
Netherlands	2,635	65,770	4,496	72,643	9,500	124,841
Nicaragua	12	300	6	123	58	1,123
Norway	1,988	31,870	1,165	12,785	1,313	12,772
Other British West Indies	3	70			11	240
Panama	249	4,653	250	8,368	186	3,933
Paraguay					34	713
Peru	15,303	164,665	15,028	101,974	11,382	56,694
Philippine Islands			450	8,309		
Poland and Danzig	560	15,000				
Portugal	200	5,728	299	2,139		
Portuguese Africa	12	245				
Rumania	6,535	53,869				
Russia in Europe	560	14,000				
Salvador	30	835	36	997	60	1,440
Scotland	376	5,800	280	3,728	4,552	39,560
Spain	515	10,481	11	175		
Sweden	3,743	68,500	11	400		
Switzerland	1,250	29,735			515	5,286
Trinidad and Tobago	28	560	11	200	4	100
Turkey in Europe	459	10,429	224	4,000		
Uruguay	71	1,890	121	1,296		
Venezuela	130	3,986	101	1,945	56	1,308
Virgin Islands of the United States	21	511	2	49	16	300
	919,802	9,993,665	306,755	2,760,939	511,541	4,319,538

TABLE 49.—*Coke exported from the United States, 1920–1922, by months.*

Month.	1920		1921		1922	
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.
January	64,989	$513,240	41,154	$465,321	34,420	$266,809
February	67,050	518,432	30,507	340,555	35,318	273,620
March	62,087	510,577	28,068	287,881	28,487	236,703
April	59,027	551,983	21,127	177,960	31,822	243,417
May	47,126	472,009	17,518	151,840	24,414	201,124
June	62,071	637,217	22,300	210,796	32,581	258,902
July	89,726	937,896	21,425	173,687	31,008	251,669
August	79,891	944,941	20,192	157,765	29,255	293,043
September	90,022	1,133,930	19,750	149,352	39,729	448,061
October	115,755	1,552,158	24,927	193,598	43,247	503,716
November	95,696	1,215,444	33,989	254,484	43,005	492,495
December	86,362	1,005,838	25,798	197,700	138,255	849,979
	919,802	9,993,665	306,755	2,760,939	511,541	4,319,538

TABLE 50.—*Coke imported for consumption in the United States, 1908–1922.*

Year.	Net tons.	Value.	Year.	Net tons.	Value.
1908	147,427	$606,294	1916	54,955	$249,514
1909	191,253	736,120	1917	24,872	146,451
1910	172,716	625,130	1918	30,168	221,880
1911	77,923	254,455	1919	16,486	140,653
1912	123,614	488,398	1920	41,143	403,175
1913	101,212	435,157	1921	30,990	336,394
1914	133,226	551,104	1922	94,228	802,987
1915	53,222	222,382			

TABLE 51.—*Coke imported into the United States, 1920–1922, by customs districts.*

District.	1920		1921		1922	
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.
Alaska	86	$1,301			799	$5,704
Buffalo	1,713	23,355	1,077	$14,156	654	4,902
Chicago		5				
Hawaii	268	3,908	449	9,582	231	1,633
Los Angeles			222	1,690	14,659	96,565
Maine and New Hampshire	280	2,125	350	3,041	1,365	12,688
Massachusetts					10,730	125,849
Michigan	1,893	18,799			58	421
Montana and Idaho	36,636	352,056	20,476	237,410	16,593	185,338
New York					8,869	75,894
Oregon			588	6,037	1,338	9,001
Philadelphia					3,068	37,637
San Francisco			7,671	63,255	31,723	222,505
Vermont	142	739	80	530	87	702
Washington	125	887	77	693	4,054	24,148
	41,143	403,175	30,990	336,394	94,228	802,987

TABLE 52.—*Coke imported into the United States, 1920–1922, by countries of origin.*

Country.	1920		1921		1922	
	Net tons.	Value.	Net tons.	Value.	Net tons.	Value.
Australia	268	$3,911	3,095	$25,685	903	$6,078
Belgium					84	1,350
Canada	40,874	399,256	22,060	255,830	18,572	200,483
England		2	5,835	54,879	73,987	590,894
Germany					342	2,067
Japan	1	6				
Scotland					340	2,115
	41,143	403,175	30,990	336,394	94,228	802,987

THE DISTRIBUTION OF COKE.

The following tables showing the quantity of beehive coke shipped by originating railroads and waterways are compiled from reports of the coke operators and therefore do not agree exactly in some respects with the records of the carriers themselves. As almost all the beehive ovens are located at the mines, the great bulk of the beehive coke produced must be transported some distance in order to reach the place of use. In 1921 92.9 per cent of the entire output of beehive coke was loaded for shipment by rail or water; in 1922 the proportion amounted to 94.9 per cent (Table 53).

In some localities, however, the furnaces that consume the coke are also located at the mines, and considerable quantities of coke produced are used locally without appearing as railroad shipments. This is notably true of the Birmingham district of Alabama.

Water-borne shipments of coke are practically confined to Monongahela River, down which a comparatively small tonnage is transported to the Pittsburgh district out of the Connellsville field.

Though many railroads originate shipments of beehive coke, the traffic is largely concentrated over three carriers, the Pennsylvania, the Monongahela, and the Baltimore & Ohio. The declining production of beehive coke has served but to emphasize the concentration of the business over these carriers. In 1918, for example, they originated 60.6 per cent of all the coke shipped, but in 1922 their share had risen to 75.3 per cent. The concentration of the traffic over a small number of roads assists the Geological Survey in estimating the current production of beehive coke. Weekly statements are courteously furnished by 23 of the principal carriers, which in 1922 loaded 96.5 per cent of the entire output. From these as a base, the total production is estimated by allowing for shipments by water, shipments over the smaller roads, and tonnage used locally. (For weekly and monthly estimates of production obtained in this way, see figs. 31 and 35.)

TABLE 53.—*Beehive coke loaded for shipment on originating railroads and waterways in the United States in 1922, by States, in net tons.*

State.	Railroad.	Shipments.	Production.	Percentage of production shipped.[a]
Alabama	Louisville & Nashville	121,685		
	St. Louis-San Francisco	80		
	Southern	65,549		
		187,314	306,209	61.2
Colorado	Denver & Rio Grande Western	71,734		
	Colorado & Wyoming	47,460		
		119,194	119,361	99.8
Georgia	Central of Georgia	8,767	8,832	99.3
Kentucky	Chesapeake & Ohio	6,230		
	Louisville & Nashville	24,292		
		30,522	30,522	100.0
New Mexico	El Paso & Southwestern	87,631	87,631	100.0
Ohio	Baltimore & Ohio; Pittsburgh & Lake Erie	104,968	99,468	105.5
Pennsylvania	Baltimore & Ohio	721,657		
	Buffalo, Rochester & Pittsburgh	62,171		
	Ligonier Valley	60,306		
	Monongahela	1,047,200		
	Pennsylvania	4,185,962		
	Pittsburgh & Lake Erie	88,375		
	Buffalo & Susquehanna; Reynoldsville & Falls Creek; Washington Run	256,849		
		6,422,520	6,839,980	93.9
Tennessee	Nashville, Chattanooga & St. Louis	13,703		
	Louisville & Nashville; Southern	760		
		14,463	86,442	16.7
Utah	Denver & Rio Grande Western	172,453	172,453	100.0

[a] Excess of shipments over production represents inclusion of screenings or withdrawal from stock.

TABLE 53.—*Beehive coke loaded for shipment on originating railroads and waterways in the United States in 1922, by States, in net tons*—Continued.

State.	Railroad.	Shipments.	Production.	Percentage of production shipped.
Virginia	Chesapeake & Ohio	4,275		
	Interstate	270,957		
	Louisville & Nashville	3,804		
	Norfolk & Western	31,104		
	Southern	38,984		
	Louisville & Nashville; Norfolk & Western; Southern	27,768		
		376,892	378,656	99.5
Washington	Northern Pacific	25,651	26,063	98.4
West Virginia	Baltimore & Ohio	166,710		
	Chesapeake & Ohio	96,181		
	Norfolk & Western	81,929		
	Western Maryland	14,994		
	Kanawha & Michigan	57,315		
		417,129	417,850	99.8
	Total railroad shipments	7,967,504		
	Total waterway shipments (Monongahela River, Pa.)	165,791		
	Grand total	8,133,295	8,573,467	94.9

TABLE 54.—*Beehive coke loaded for shipment on originating railroads and waterways in the United States in 1922, by routes, in net tons.*

Route.	State.	Quantity.		Percentage of total.
		By States.	Total.	
Railroads:				
Baltimore & Ohio	Pennsylvania	721,657	888,367	10.9
	West Virginia	166,710		
Baltimore & Ohio and Pittsburgh & Lake Erie	Ohio	104,968	104,968	1.3
Buffalo, Rochester & Pittsburgh	Pennsylvania	62,171	62,171	.8
Buffalo & Susquehanna; Reynoldsville & & Falls Creek; Washington Run	do	256,849	256,849	3.1
Central of Georgia	Georgia	8,767	8,767	.1
Chesapeake & Ohio	Kentucky	6,230	106,686	1.4
	Virginia	4,275		
	West Virginia	96,181		
Colorado & Wyoming	Colorado	47,460	47,460	.6
Denver & Rio Grande Western	do	71,734	244,187	3.0
	Utah	172,453		
El Paso & Southwestern	New Mexico	87,631	87,631	1.1
Interstate	Virginia	270,957	270,957	3.3
Kanawha & Michigan	West Virginia	57,315	57,315	.7
Ligonier Valley	Pennsylvania	60,306	60,306	.7
Louisville & Nashville	Alabama	121,685	150,121	1.9
	Kentucky	24,292		
	Tennessee	340		
	Virginia	3,804		
Louisville & Nashville; Norfolk & Western; Southern	do	27,768	27,768	.3
Monongahela	Pennsylvania	1,047,200	1,047,200	12.9
Nashville, Chattanooga & St. Louis	Tennessee	13,703	13,703	.1
Norfolk & Western	Virginia	31,104	113,033	1.4
	West Virginia	81,929		
Northern Pacific	Washington	25,651	25,651	.3
Pennsylvania	Pennsylvania	4,185,962	4,185,962	51.5
Pittsburgh & Lake Erie	do	88,375	88,375	1.1
St. Louis-San Francisco	Alabama	80	80	
Southern	do	65,549	104,953	1.3
	Tennessee	420		
	Virginia	38,984		
Western Maryland	West Virginia	14,994	14,994	.2
Total railroad shipments		7,967,504	7,967,504	98.0
Waterways: Monongahela River	Pennsylvania	165,791	165,791	2.0
Grand total		8,133,295	8,133,295	100.0

WORLD'S PRODUCTION.

The United States in 1922 regained the position as the world's leading producer of coke, which it had lost to Germany in 1921. For some years the United States produced as much as Great Britain and Germany combined. During the great depression of the iron and steel industry which reached its depth in both England and America in 1921, the production of the United Kingdom dropped from about 13,000,000 tons a year to 4,647,000 tons, and the output of the United States fell to less than half of the normal amount. In Germany, however, the pressure to export coke in part payment of reparations due to France and to others of the Allied powers brought about an actual increase in production over the years immediately preceding.

Germany's lead was, however, brief. Even under the handicap of the coal and railroad strikes of 1922, the United States produced 33,678,000 metric tons to Germany's 29,917,000. In fact, out of the approximate total of 82,000,000 tons produced in the world in 1922, 41 per cent was contributed by the United States.

The statistics in the following table have been compiled by W. I. Whiteside, of the Geological Survey, under the direction of B. L. Johnson. Trade sources have been consulted where official publications were not to be had. The unit of measurement employed is the metric ton, which will be most easily remembered by American readers as roughly equivalent to the gross ton.

TABLE 55.—*Coke produced in the principal countries of the world, 1913 and 1920–1922.*

[In metric tons of 2,204.6 pounds. Gas-house coke is not included.]

Country.	1913	1920	1921	1922
Algeria	[a]	29,185	12,059	[a]
Australia (New South Wales)	303,405	576,678	601,600	244,085
Austria	2,598,782	[b]	[b]	[b]
Belgium	3,523,000	1,835,400	1,402,610	2,849,884
British India[c]	[a]	365,465	276,927	327,676
Canada	1,388,438	1,203,991	884,070	635,115
China (exports)	[a]	[a]	35,157	[a]
Czechoslovakia	[d]	1,590,623	1,135,837	639,290
France	4,027,424	1,716,418	1,860,706	2,362,000
Germany[e]	35,065,847	26,720,535	28,090,822	29,917,411
Hungary	160,073	[a]	[a]	[a]
Italy	498,442	95,727	34,022	167,953
Japan proper (natural coke)[f]	129,101	67,172	64,365	[a]
Taiwan	[a]	[a]	32,000	[a]
Netherlands		138,987	228,605	247,315
Poland	[g]	[g]	[g]	[h] 678,972
Rhodesia (Southern)	20,137	95,526	116,316	97,670
Russia (Donetz Basin)	4,437,000	10,000	104,025	112,333
Spain	595,677	280,717	446,087	383,151
Union of South Africa	8,478	20,813	22,638	36,823
United Kingdom[i]	13,004,420	12,813,849	4,647,382	9,180,765
United States	42,002,008	46,579,196	22,940,425	33,678,161

[a] Data not available.
[b] See Czechoslovakia.
[c] Represents only coke made at collieries.
[d] See Austria.
[e] Includes all of Upper Silesia in 1913, 1920–21, and January–May, 1922; German Upper Silesia, June–December, 1922; and Saar in all four years.
[f] Some coke is also manufactured, but no statistics concerning it are available. In 1919 the quantity of coal made into coke was 829,000 tons, suggesting a production of coke of 540,000 tons.
[g] See Germany.
[h] June–December. Included under Germany from January to May.
[i] In Great Britain the production of gas-house coke, not included above, is especially important and was as follows: 1913, 7,956,419 metric tons; 1920, 8,440,471 tons; 1921, 6,907,608 tons; 1922, 7,861,908 tons.

In comparison with 1913, when about 108,000,000 tons was produced, the world's output of 1922 represented a decrease of 25 per cent. No less striking than the decline in total output was the change created by the war in the relative rank of the countries of eastern Europe. Russia in 1913 produced 4,400,000 tons, the entire output coming from the Donetz Basin, just north of the Black Sea. In 1922 the reported output was only 112,000 tons. An important center of coke production and iron and steel manufacture is the Silesian coal field, which in 1913 was divided between Germany, Austria, and Russian Poland. By the treaties of peace the Austrian mines and coke ovens went chiefly to Czechoslovakia, which became a considerable producer of coke. Through the partition of German Upper Silesia the new Republic of Poland also became a producer of coke. Of the 18 metallurgical coke works in Upper Silesia, 12 are now on Polish territory, and they are the only coke plants owned by the new Poland. In 1913 what is now Poland, though producing coal and pig iron, was completely dependent upon outside sources for coke and procured 776,000 tons from Germany, Austria, and the Donetz region of Russia. The transfer of these coke plants to Poland and Czechoslovakia reduces by an equivalent amount the production of Germany and Austria, and the supplies of Austria are now insignificant.

BY-PRODUCTS.

SUMMARY OF BY-PRODUCTS IN 1922.

Table 56 presents a summary of the by-products of coke-oven operation in 1921 and 1922. The total receipts from sales of by-products in 1922 were $83,389,000. This figure does not include sales of coke breeze (Table 35, p. 728), which amounted to $1,583,399. Sales of all products other than large coke thus aggregated $84,972,000. To this should be added the values of tar and breeze used by producers, which were reported as $6,624,000 and $3,653,000, respectively. This raises the total recoveries of all by-products to $95,249,000, an average of $2.32 per ton of coal coked and of $3.32 per ton of coke produced.

TABLE 56.—*By-products obtained from coke-oven operations in the United States in 1921 and 1922.*

Product.	Production.	Sales.		
		Quantity.	Value.	
			Total.	Average.
1921.				
Tar.....gallons..	253,051,649	135,293,047	$5,645,309	$0.042
Ammonia:				
Sulphate.....pounds..	528,638,763	530,041,716	13,100,703	.025
Ammonia liquor (NH_3 content).....do....	31,899,398	35,102,561	3,515,416	.100
Other forms (NH_3 content).....do....	191,162	53,993	10,135	.188
			16,626,254	
Sulphate equivalent of all forms.....do....	657,001,003	670,667,932		
Gas:				
Used under boilers, etc.....M cubic feet..	[a]310,188,713	12,122,777	1,120,087	.092
Used in steel or affiliated plants.....do....		98,352,049	10,593,204	.108
Distributed through city mains.....do....		43,826,172	14,249,961	.325
	310,188,713	154,300,998	25,963,252	.168

[a] Includes gas wasted and gas used for heating retorts.

TABLE 56.—*By-products obtained from coke-oven operations in the United States in 1921 and 1922*—Continued.

Product.	Production.	Sales. Quantity.	Sales. Value. Total.	Sales. Value. Average.
1921.				
Light oil and derivatives:				
Crude light oil ---gallons	[b] 76,917,269	2,433,078	$240,111	$0.099
Benzol, crude ---do	1,494,329	1,536,312	343,463	.224
Benzol, refined ---do	4,912,131	5,302,709	1,268,258	.239
Motor benzol ---do	48,052,882	50,022,573	8,966,686	.179
Toluol, crude ---do	26,529	26,529	4,410	.166
Toluol, refined ---do	942,982	808,964	228,968	.283
Solvent naphtha ---do	3,822,776	2,881,656	510,509	.177
Other light-oil products ---do	590,173	291,635	12,310	.042
	[c] 59,841,802	[d] 63,303,456	[d] 11,574,715	[d] .183
Naphthalene:				
Crude ---pounds	2,827,756	1,652,466	40,659	.025
Refined ---do	115,229	331,057	18,676	.056
	2,942,985	1,983,523	59,335	.030
Other products			121,813	
Value of all by-products sold			59,990,678	
1922.				
Tar ---gallons	327,779,734	162,204,417	6,419,743	.0396
Ammonia:				
Sulphate ---pounds	695,543,349	714,752,882	17,818,236	.0249
Ammonia liquor (NH_3 content) ---do	50,036,646	48,523,937	4,559,535	.0940
Other forms (NH_3 content) ---do	693,782	192,549	12,041	.0625
			22,389,812	
Sulphate equivalent of all forms ---do	898,465,061	909,618,826		
Gas:				
Used under boilers, etc ---M cubic feet	[a] 442,671,114	19,123,814	1,251,325	.0654
Used in steel or affiliated plants ---do		144,976,030	15,942,446	.1100
Distributed through city mains ---do		56,930,253	20,326,648	.3570
Sold for industrial use ---do		10,352,921	1,104,901	.1066
		231,383,018	38,625,320	.1669
Light oil and derivatives:				
Crude light oil ---gallons	[e] 101,437,555	5,138,095	630,768	.1228
Benzol, crude ---do	2,666,177	2,665,889	698,437	.2620
Benzol, refined ---do	10,419,504	9,590,459	2,736,944	.2854
Motor benzol ---do	57,025,699	54,930,203	10,491,309	.1916
Toluol, crude ---do	38,159	3,938	652	.1650
Toluol, refined ---do	1,955,119	1,906,122	556,363	.2919
Solvent naphtha ---do	2,983,858	2,861,482	538,512	.1882
Other light-oil products ---do	580,058	212,712	14,949	.0703
	[c] 75,668,574	[d] 77,308,900	[d] 15,667,934	[d] .2027
Naphthalene:				
Crude ---pounds	6,107,742	3,298,851	52,103	.0158
Refined ---do	1,810,972	1,589,084	79,149	.0498
	7,918,714	4,887,935	131,252	.0269
Other products			154,507	
Value of all by-products sold			83,388,568	

[a] Includes gas wasted and gas used for heating retorts.
[b] Of this quantity 75,760,334 gallons was refined on the premises to make the derived products listed.
[c] Excludes crude light oil produced.
[d] Includes sales of crude light oil.
[e] Of the crude light oil 98,432,100 gallons, including 4,200,000 gallons of purchased oil, was refined on the premises to make the derived products listed.

CHANGES IN VALUE OF BY-PRODUCTS, 1913–1922.

Valuable as are the by-products, the principal source of revenue for the by-product coke operators remains the coke itself. In 1922 the average value of coke produced was $6.59 a ton, almost twice the value of all the by-products per ton of coke produced, which amounted to $3.32 (Table 57, fig. 48). In 1913 the average value of the coke was $3.82 and of the by-products $1.41, a ratio of 2½ to 1.

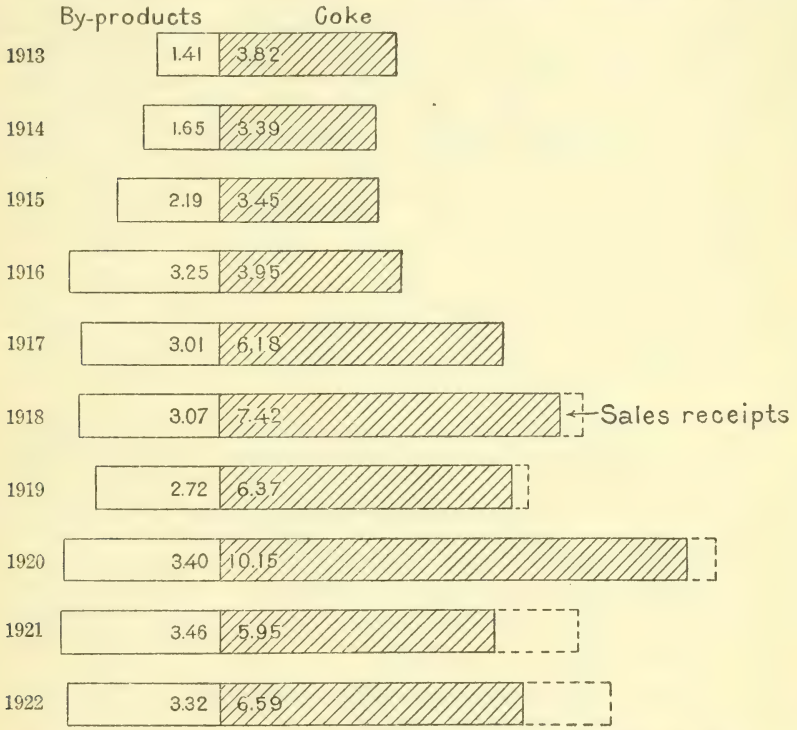

FIGURE 48.—Average value of by-product oven coke and of by-products per ton of coke produced, 1913–1922.

Value of by-products includes all receipts from sale of by-products and breeze and also value of tar and breeze used by producer. Value of coke is average for all coke produced, including producers' estimates of value of coke used but not sold, except that for years 1918 to 1922 the average receipts on all coke sold are shown by the dotted extensions of the bars.

In one year—1916—the value of the by-products almost equaled the value of the coke. The war-time prices of the benzol products were at their peak, and the total value of by-products per ton of coke produced was $3.25, more than twice as great as that of 1913. On the other hand, the price of coal had not yet advanced so far as to force a great increase in the selling price of coke, and the average value placed by the producers upon the coke made in that year was only $3.95. Subsequent changes in commodity prices have tended to restore the former ratio between by-products and coke. While coke has been increasing in value since 1916, the value of the by-products as a group has been roughly constant, as shown by the bars of Figure 48.

The income from by-products can best be measured in terms of the value per ton of coke produced or per ton of coal charged. The

former unit has been used in Table 57. In this table the statistics for the years 1913 to 1917 represent the total value of the by-products produced (including allowance for the value of products obtained but not sold) divided by the total number of tons of merchantable coke. Beginning with 1918 they represent the total receipts from sales divided by the total number of tons of coke produced. Except for changes in the stock on hand, which probably would not introduce material error, the records of sales are equivalent to the total output for all the products other than tar and breeze. For these two the value of the quantity used by the producer but not sold has been added to obtain the total value of all by-products. Thus in 1922 the average receipts from sales of ammonia and its compounds amounted to 78 cents per ton of coke, sales of tar to 22 cents per ton of coke, and sales of other products brought the total cash receipts from sales to $2.91 for the year. To this figure should be added 23 cents for the value of tar produced but not sold and 18 cents for the value of breeze (including a small quantity sold). This makes the total value of all by-products obtained, whether sold or used, $3.32 for each ton of coke drawn in 1922.

Separate figures are not given in Table 57 for naphthalene, because its contribution to the revenue of the operator is small. Sales of naphthalene in 1918 gave a credit of 2.5 cents per ton of coke; in 1919 the figure was 0.8 cent; in 1920, 1.6 cents; in 1921, 0.3 cent; and in 1922, 0.5 cent.

It must be understood that these values do not represent a net profit or a net deduction from the cost of making coke. They are the gross receipts from sales of the several by-products, from which must be deducted the cost of recovery before the net contribution from by-products is known. Thus, while the light-oil derivatives were sold at prices that brought 55 cents for each ton of coke produced, at several plants the net profits were considered to be too small to justify recovery, and the light oils were left in the gas, producing, in consequence, a richer gas with higher heating value and candlepower.

TABLE 57.—*Value of by-products and of coke, including breeze, per ton of coke produced in the United States, 1913–1922.*

Product.	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Ammonia and its compounds	$0.63	$0.68	$0.70	$0.74	$0.79	$1.02	$1.06	$1.16	$0.84	$0.78
Light oil and its derivatives (including naphthalene)	[a]	[a]	.52	1.58	1.30	.99	.50	.61	.59	.55
Surplus gas sold or used	.45	.54	.61	.57	.51	.53	.66	1.05	1.31	1.35
Tar	.22	.26	.25	.26	.25	.24	.28	.21	.29	.22
Miscellaneous products	.03	.09	.03	.01	.06	.09	.03	.01	.01	.01
	1.33	1.57	2.11	3.16	2.91	2.87	2.53	3.04	3.04	2.91
Tar used	[b]	[b]	[b]	[b]	[b]	.08	.09	.22	.26	.23
Breeze produced	[c]	[c]	[c]	.09	.10	.12	.10	.14	.16	.18
Total value of by-products, including those not sold	1.41	1.65	2.19	3.25	3.01	3.07	2.72	3.40	3.46	3.32
Value of coke produced	3.82	3.39	3.45	3.95	6.18	[d] 7.42	[d] 6.37	[d] 10.15	[d] 5.95	[d] 6.59
Total value of coke and by-products	5.23	5.04	5.64	7.20	9.19	10.49	9.09	13.55	9.41	9.91

[a] Included under "Miscellaneous products."
[b] Included in tar sold.
[c] Estimate included in total.
[d] The average receipts per ton of coke sold during these years were $7.88 in 1918, $6.58 in 1919, $10.77 in 1920, $7.72 in 1921, and $8.45 in 1922.

RELATIVE VALUE OF THE SEVERAL BY-PRODUCTS.

How the several by-products have changed in value is shown graphically in Figure 49. The changes from year to year are due in part to changes in the unit quantities recovered per ton of coke produced but chiefly to variations in the market price. The diagram brings out clearly the sudden advent of the benzol group as a producer of revenue. Before 1914 only one company recovered benzol from its gas, the figures in consequence being combined with other products to avoid disclosing its operations, but in 1915 the benzol group had become third in importance as a source of revenue. The average value of the light oil, benzol, toluol, solvent naphtha, and others of the group was 52 cents per ton of coke produced in 1915, as against 61 cents for gas and 70 cents for ammonia. In 1916 the value of the benzols jumped to $1.58 per ton of coke, almost as much as the

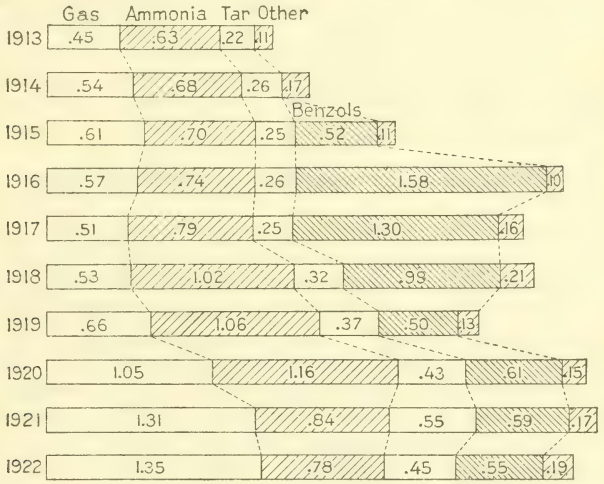

FIGURE 49.—Value of the several by-products per ton of coke produced, 1913–1922.

Data for gas represent value of all surplus; for ammonia, sulphate and all other forms; for tar, both tar sold and tar used by producer. Naphthalene is included in benzol group beginning with 1915; prior to that date both naphthalene and benzol are included in other products. Breeze is included in other products.

combined value of all other products. Lower prices, resulting in part from Government regulation after the United States entered the war, were the cause of a shrinkage in the value of the benzol group to $1.30 in 1917 and 99 cents in 1918. With the collapse of the munitions demand after the armistice was signed, the value of the benzol group has dropped to 50 or 60 cents per ton of coke. Included in the benzol group as here defined is naphthalene, the value of which in terms of coke produced is, however, too small to be shown in the diagram.

Receipts from the sales of ammonia also increased with the increasing prices of the war, but in much smaller ratio. Because of contracts and the Government's maximum prices, the average receipts from all sales of ammonia, as reported by coke-oven operators, do not parallel exactly the course of spot prices of ammonia shown in Figure 26. The high point in receipts from sales of ammonia was reached not during the war but in 1919 and 1920, when a credit of

$1.06 and $1.16 respectively was earned per ton of coke produced. Declining prices of sulphate have since carried ammonia receipts down to 78 cents a ton in 1922.

How does it happen that with prices of light-oil derivatives and ammonia declining since the war the total value of all by-products has remained constant? The answer to this question lies in the remarkable rise that began in 1919 in the value of the surplus gas. From third place as a source of auxiliary revenue during the war years gas has risen to first place, the value in 1922 approximately equaling the combined value of ammonia and the light-oil derivatives. From 1913 to 1922 the value of the surplus gas trebled. In 1913 it was 45 cents per ton of coke produced, and in 1922 it was $1.35. The elements in this increased price are discussed on page 783.

The value of tar, which here includes tar used by the producer as well as that sold, has shown a much smaller increase. In 1913 it was 22 cents to the ton of coke, in 1921 it reached a maximum of 55 cents, and in 1922 it was 45 cents.

Chief among the group of other products shown in the diagram is the breeze. Including the value of breeze used by the producer but not sold, this fine coke furnished a credit of 18 cents per ton of large coke produced in 1922.

FLUCTUATION IN PRICES OF BY-PRODUCTS.

The changes in the market prices of the several by-products, which have been the principal cause of the variations in the revenue from by-products per ton of coke above referred to, are suggested by Figure 50 and Table 58. The quantities here shown represent not the spot market prices, which fluctuated so violently and within so wide a range in the disturbed market of the war as to make trade quotations of little value, but rather the average receipts from all sales reported by the producers. As these sales included shipments on contracts as well as offerings on the spot market, the averages do not by any means equal the highest point touched by transactions in these products. Sales of toluol, for example, were reported in trade papers at $6 a gallon at one time during the war, but the average receipts on all toluol sold by the producers rose no higher than $2.85, the figure for 1916. Even the lower figure brings out startlingly the insatiable demand for this substance, for $2.85 was exactly ten times the price prevailing before the war. In the same way the export price of sulphate of ammonia touched 5½ cents a pound in 1918, although the average receipts from sales reported in that year were only 4½ cents. Benzol quotations touched 90 cents a gallon, though the highest annual average in the record of sales receipts was 62 cents. In 1916, when the average receipts for solvent naphtha were 28 cents a gallon, the minimum spot-price quotations hung about 40 cents for six months. These examples will make clear both the strength and the weakness of the records of average receipts. They do not show the extremes of the market, but they do indicate far more accurately than the spot quotations the average level at which all sales were made.

The curve for benzol in Figure 50, it should be noted, represents "refined benzol," which is not the same grade as the 90 per cent benzol shown in Figures 57 and 58 (p. 775).

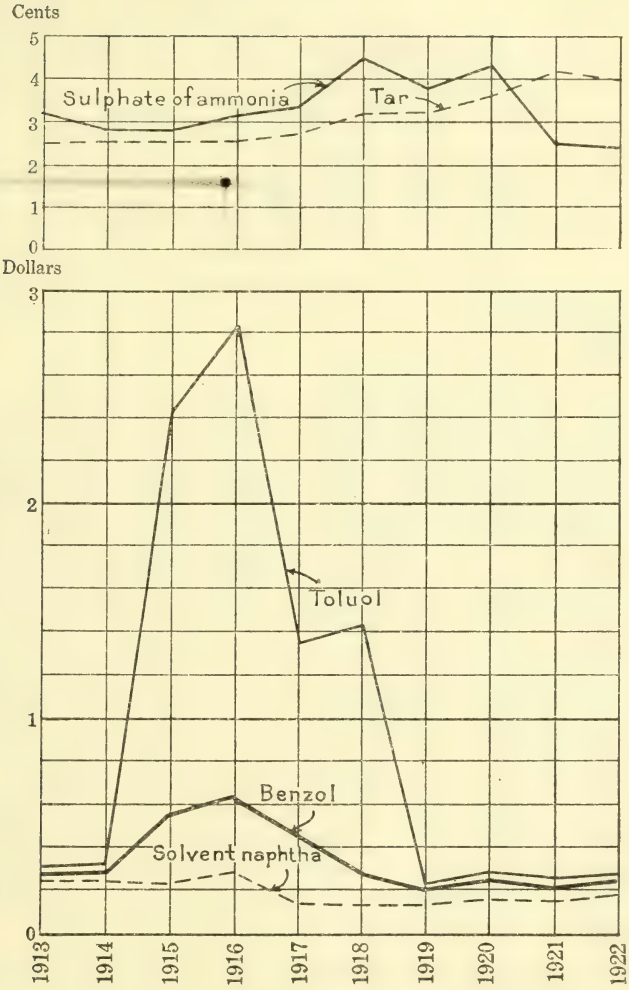

FIGURE 50.—Average receipts per unit of principal by-products sold, 1913–1922.

Curve for sulphate of ammonia represents average per pound; for tar, toluol, refined benzol, and solvent naphtha, average per gallon.

TABLE 58.—*Average receipts per unit of coke-oven by-products sold, 1913–1922.*

[The figures in this table for 1913 to 1917 represent "average value of by-products produced and sold." For 1918 to 1922 they represent "average receipts from sales." The two sets of figures are probably comparable for practical purposes.]

	Tar.	Sulphate.	Surplus gas.	Benzol, refined.	Motor benzol.	Toluol, refined.	Solvent naphtha.	Naphthalene.	
								Crude.	Refined.
Unit	Gallon.	Pound.	M cubic feet.	Gallon.	Gallon.	Gallon.	Gallon.	Pound.	Pound.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	
1913	2.5	3.1	8.8	[a] 27	[b]	[a] $0.29	[a] 25	[b]	
1914	2.6	2.8	9.8	[a] 26	[b]	[a] .33	[a] 25	[b]	
1915	2.6	2.8	10.2	56.8	[c]	2.45	24.0	[d] 10.0	
1916	2.6	3.1	9.8	62.4	[c]	2.85	28.4	[d] 3.4	
1917	2.7	2.4	8.7	45.0	[c]	1.37	16.6	[d] 3.3	
1918	3.2	4.5	8.7	27.5	[c]	1.43	14.1	2.8	6.6
1919	3.2	3.8	8.6	20.6	[c]	.263	15.2	2.0	4.1
1920	3.7	4.3	14.0	26.0	22.7	.300	18.1	2.7	6.1
1921	4.2	2.5	16.8	23.9	16.6	.283	17.7	2.5	5.6
1922	4.0	2.5	16.7	28.5	19.1	.292	18.8	1.6	5.0

[a] Trade quotations, New York market; used to avoid disclosing individual operators' reports.
[b] No data.
[c] Not reported during the war.
[d] Data uncertain.
[e] Crude and refined not separated prior to 1918.

AVERAGE YIELD OF BY-PRODUCTS.

The yield of by-products per ton of coal charged was on the whole slightly less in 1922 than in 1921—in part, at least, because of the difficulty in procuring coal of the usual quality, but chiefly because the more active demand called into production older plants that had been closed the year before. Nevertheless, a gratifying increase in the average recovery of by-products has marked the last ten years (fig. 52). Recoveries of tar, about 7 gallons to the ton of coal at the beginning of the period shown, now amount to 8 gallons and in 1921 touched the high point of 8.8 gallons. Recoveries of ammonium sulphate, or its equivalent, after a temporary decline in 1916 and 1917 now average 22 pounds to the ton. Recoveries of light oil, from less than 2 gallons to the ton of coal in 1915, when benzol-recovery apparatus was being installed at most plants for the first time, now average 2.7 or 2.8 gallons. The marked increase in the quantity of surplus gas per ton of coal is due in part to increased efficiency of operation and improved design of the newer plants, in part to the substitution of producer gas for coke-oven gas to heat the ovens at certain plants, thus releasing a larger proportion to be disposed of as surplus, and in part to changes in quality of coal used.

TABLE 59.—*Average yield of coke and by-products per net ton of coal charged in by-product ovens in the United States, 1915–1922.*

Product.	1915	1916	1917	1918	1919	1920	1921	1922
Coke—pounds	1,440	1,438	1,424	1,410	1,402	1,395	1,376	1,390
Tar—gallons	7.1	7.0	7.0	7.1	8.1	8.2	8.8	8.0
Ammonium sulphate (or equivalent)—pounds	20.1	17.7	17.8	18.9	20.8	21.4	22.8	21.9
Light oil—gallons	1.54	[a]	[a]	2.4	2.7	[b] 2.7	[b] 2.8	[b] 2.7
Gas:								
Total—M cubic feet	11.0	11.0	10.7	10.4	11.6	10.8	10.8	10.8
Surplus sold or used—do	4.3	4.2	4.1	4.3	5.4	5.2	5.4	5.6
Burned in coking process—do	6.3	6.4	6.0	5.7	5.9	5.4	5.1	5.0
Wasted—do	.4	.4	.6	.4	.3	.2	.3	.2

[a] Records not comparable.
[b] Average for plants now recovering light oil.

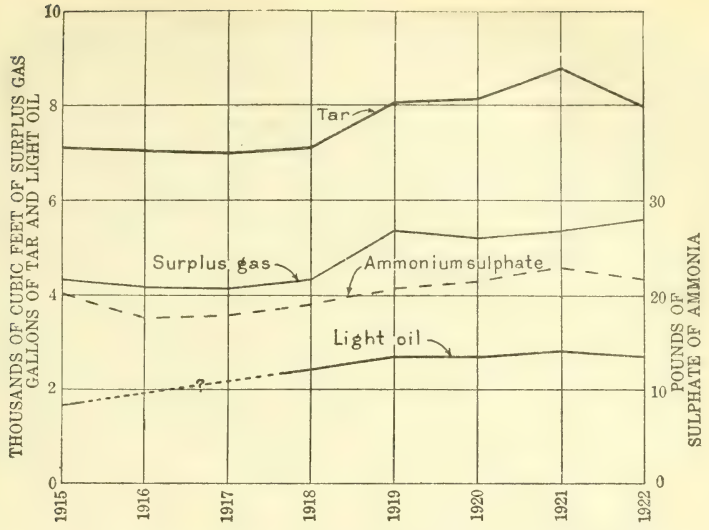

FIGURE 51.—Average yield of by-products per net ton of coal charged, 1915–1922.

The total output of the several by-products has increased somewhat more rapidly than that of coke itself, because of the increased efficiency of by-product recovery. Figure 52 shows at a glance the growth in annual production of the principal by-products. The curves follow what is essentially the course of the production of coke itself with the exception of the curve for light oil, which rises abruptly with the outbreak of the European war.

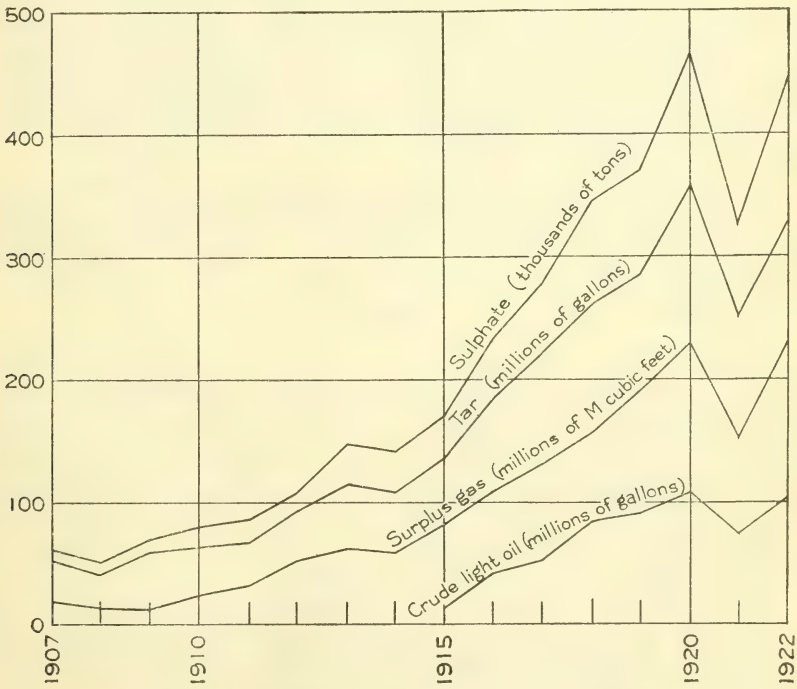

FIGURE 52.—By-products produced at coke plants, 1907–1922.

DEMAND FOR BY-PRODUCTS.

In the discussion of capacity of by-product ovens now built or under construction, it was pointed out that the demand for coke sets a limit beyond which the industry may not profitably go. Other limits are set by the demand for by-products. Although the markets of the country have adjusted themselves to a rapid increase in the supply of by-products thus far, it does not follow that they can absorb an indefinite increase without decline in price. It is a common error to calculate the potential value of the by-products of bituminous coal by multiplying the total quantity of raw coal burned in the country by the average yield of by-products from the best by-product coal and multiplying this product in turn by the high market prices of the last few years. Such estimates have contributed largely to a recognition of the wastefulness of burning the raw coal and have made clear the need for further study of the problems of by-product utilization, but they have also bred extravagant ideas as to the rate at which development of by-product coking can go on. If all the bituminous coal ordinarily produced in the United States were coked and the by-products were recovered, ten or twelve times the present quantities of by-products would be thrown on the market, which could not absorb so great a quantity immediately.

Further construction of by-product ovens therefore depends upon the maintenance of a nice balance between the demand for the coke and for the several by-products. In Mineral Resources for 1921, Part II, page 423, it was stated by R. S. McBride that

> if a price for coke comparable with its value as a substitute for anthracite were assured, and if approximately $3 could be realized from the sale of by-products for each ton of coke produced, then the construction of many more by-product ovens might safely go forward. Expectation of success in such an advance must be based on the further development of the demand for household coke and the substitution of coke by-products for other more expensive commodities. Tar can be used as a liquid fuel, gas for public-utility supply, light oil as a motor fuel, and ammonium sulphate in place of Chilean nitrate for fertilizers. But any development of this sort must and will be made gradually.

An expanding market for those products that will stand transportation and an adequate local outlet for the gas is thus of critical moment to the by-product coke industry. To a discussion of those markets, of the trend of prices, and of the available supplies, the rest of this chapter is devoted.

TAR.

A part of the tar produced by coke ovens is sold to refiners, who recover the basic materials from which are derived the many organic chemicals that have made coal tar famous. The quantities produced, however, are now far in excess of the needs of the refiners, and tar must therefore seek its place in the liquid-fuel market in competition with petroleum and ultimately with the solid fuel coal. The tar of coke ovens thus comes into competition with the product of gas plants. Coke-oven tar and coal-gas tar, both derived from the distillation of coal, are closely similar.

The coke manufacturer is interested primarily in the quality of his coke, whereas the city gas company is interested primarily in the illuminating and calorific value and yield of the gas. These divergent requirements have resulted in the development of different designs of apparatus for the two purposes, which

give tars of somewhat different quality. An important difference is in the amount of insoluble matter or free carbon, which is present in amounts not exceeding 25 per cent in the tar from coal-gas plants and 10 per cent in the tar from coke ovens. Another difference * * * is that coal-gas tar contains important amounts of tar acids (phenol, cresol), but tar from coke ovens contains relatively small amounts of these important substances.[7]

Coal-gas tar therefore sometimes brings slightly higher prices than coke-oven tar. On the other hand, water-gas and oil-gas tar, which result from the cracking of petroleum oils, differ materially from coal tar in composition, yield fewer and less valuable derivatives, and though purchased by tar refiners are chiefly valuable as liquid fuel. The price of water-gas tar ranges accordingly somewhat below the price of coal-tar.

Of the four sources of tar, coke ovens now contribute by far the largest share (fig. 53 and Table 60), and their proportion is rapidly increasing. In 1922 the production of coke-oven tar was 68 per cent of the total, against 55 per cent in 1915, and for every gallon produced by coal-gas plants 7 gallons is now produced by coke ovens.

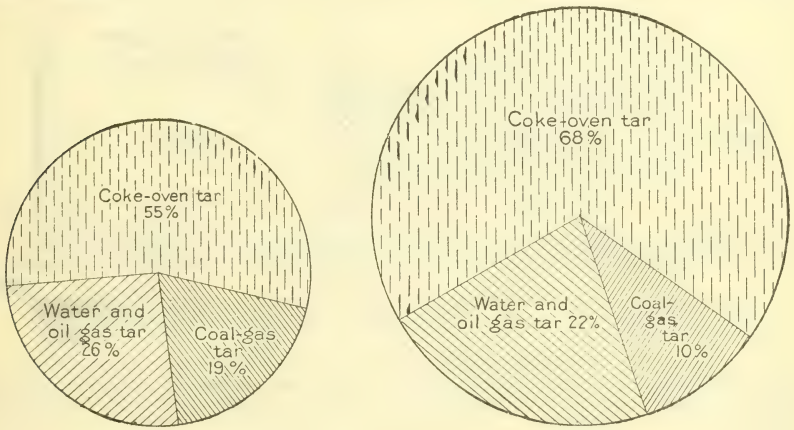

FIGURE 53.—Source of gas tar produced in the United States, 1915 and 1922.
Production includes tar not sold but used by producer. Data for water and oil gas tar in 1915 partly estimated.

TABLE 60.—*Tar produced by coal, oil, and water gas plants and by coke ovens, 1915 and 1922.*

	Gallons.		Per cent.	
	1915	1922	1915	1922
Coke ovens	[a]138,414,601	327,779,734	55.1	68.2
Coal-gas plants	47,863,192	48,082,228	19.0	10.0
Total coal tar	186,277,793	375,861,962	74.1	78.2
Water-gas plants	[b]65,000,000	97,232,985	25.9	20.3
Oil-gas plants		7,322,043		1.5
Grand total	251,277,793	480,416,990	100.0	100.0

[a] Quantity "produced and sold," which from yield per ton of coal is evidently equivalent to total production.
[b] Estimated from the known quantity of oil used.

[7] United States Tariff Commission, Census of dyes and coal-tar chemicals, 1918, p. 15.

The disposition made by the producers of the tar recovered in 1922 is shown in Figure 54. Most of the coal-gas tar was sold, presumably to refiners, though a small quantity was refined by the producers themselves. A little more than 1 per cent was used as boiler fuel about the plant, and the remainder was refined on the premises or otherwise used by the producer.

Less than half of the water-gas and coke-oven tar, on the other hand, was sold. How much of that sold went to tar refiners is not known, but undoubtedly the greater part of the water-gas tar sold was used for boiler fuel, and a considerable part of the coke-oven tar sold was burned either under boilers or in open-hearth furnaces not directly associated with the coke plants.

The general interest in the development of a domestic coal-tar dye industry, though most welcome, has given rise to a popular misconception of a by-product coke plant as a drug and dye factory. In reality the coke-oven operator separates but few of the many substances present in the coal. The crude materials of organic chemistry that he produces are an incident to his main purpose. The

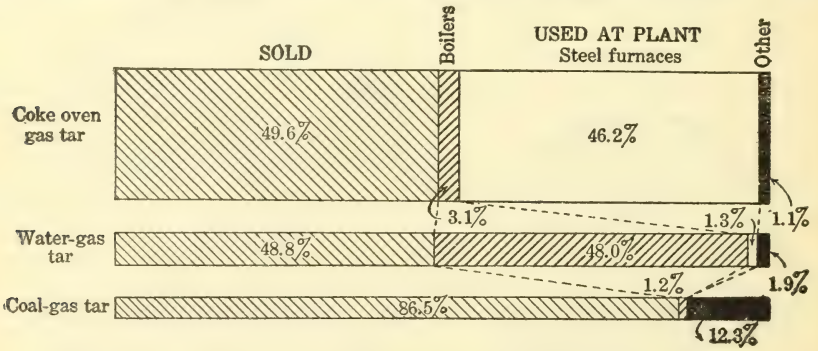

FIGURE 54.—Disposition of tar produced by coke ovens and gas works in 1922.

Bars show percentage of output that was sold (business of purchaser not known) and percentage used at plant, classified into tar used as fuel under boilers, tar used in open-hearth furnaces and other affiliated works, and tar used otherwise and refined on premises. Width of bars is proportional to quantity produced.

refining of tar and the manufacture of the complex derivatives are distinct industries that need not be and ordinarily are not conducted by the same corporation that produces the crude tar.

The real purpose of the by-product oven is to make possible complete utilization of the heat energy locked up in the raw coal by breaking it into its constituent parts. As a liquid fuel tar can be burned with a high degree of efficiency. Its heating value is about 16,000 British thermal units per pound, a value greater than that of coal and not far short of that of crude petroleum. Typical fuel oils range from 17,000 to 20,000 British thermal units per pound.

Concerning the use of tar as a metallurgical fuel, Sperr and Bird[8] state:

> The use of tar for fuel, especially in steel manufacture, has rapidly increased during the past few years, and many of the larger steel companies, operating their own by-product coke plants, do not sell any of their tar for distillation purposes but use it exclusively for fuel. In open-hearth practice the consumption of tar per ton of steel is 10 per cent less than the consumption of fuel oil.

[8] Sperr, F. W., and Bird, E. H., By-product coking: Jour. Ind. and Eng. Chemistry, January, 1921, pp. 26 et seq.

It is advantageously employed in combination with producer gas. The resulting flame has a much better melting efficiency than that of straight producer gas, and the increase in the capacity of the furnace is much greater than would be accounted for on the basis of the heating value of the fuel used.

The growing demand for tar in metallurgical work is reflected in the increasing proportion of the output consumed by the producer (fig. 55), which has risen from 23.9 per cent in 1918 to 50.5 per cent in 1922. The tendency has been accelerated by shortages of other fuel, as shown by the sudden increase in 1920, when the price of coal and fuel oils reached the highest point on record. At 4 cents a gallon, the average receipts for tar sold in 1922, the price per barrel would be $1.68, a price that is not far from the level of fuel-oil prices in recent years. Under many conditions tar may be substituted for fuel oil, and as the present annual output of tar from all sources—including coal, oil, and water gas—is only 11,000,000 barrels, against a present production of fuel oil of 250,000,000 barrels,[9] the market for tar in this direction appears indefinitely expansible.

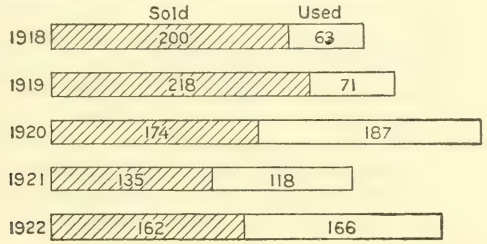

FIGURE 55.—Coke-oven tar produced and sold in the United States, 1918–1922. Figures represent millions of gallons. Quantity used computed by subtracting sales from production, ignoring changes in stocks.

By separating the records for "furnace" coke plants from those not associated with iron and steel companies, as is done in Table 61, the trend in utilization of tar is made still clearer. Practically the entire production of the nonfurnace plants was sold in both 1921 and 1922. In 1921 the furnace plants sold only 43 per cent of their output, and in 1922 the furnace group increased its consumption in affiliated open-hearth or other metallurgical plants to 152,000,000 gallons, or 56 per cent of its entire output, and sold only 40 per cent. In part this increase in consumption at the plants reflected the shortage of coal during the strike of 1922. It is well understood in the coal-products trade that a strike or serious car shortage has a double effect on the supply of tar—it not only curtails the production of tar as the production of coke declines, but it also leads producers to use a larger proportion of their own tar than usual in order to protect their supplies of coal.

[9] The production of fuel and gas oil in the United States in 1922, according to the Bureau of Mines, was 250,000,000 barrels. Besides this a very large amount of crude oil is available for fuel.

TABLE 61.—*Disposal of coke-oven tar produced in the United States in 1921 and 1922, in net tons.*

	1921 [a]			1922		
	Furnace plants.	Other plants.	Total.	Furnace plants.	Other plants.	Total.
Sold	94,958,276	40,334,771	135,293,047	109,500,273	52,704,144	162,204,417
Used:						
As fuel under boilers	24,518,552	89,800	24,608,352	9,806,520	307,282	10,113,802
In open-hearth or other metallurgical plants	98,739,432	207,645	98,947,077	151,797,400	1,143	151,798,543

[a] The classification between furnace and other plants here used is slightly different from that in the corresponding table of this report for 1921, and the figures are changed accordingly.

The total output of coke-oven tar in 1922 was 328,000,000 gallons. (See Table 62.) The distribution of the output, by States, is roughly proportional to the coke produced, although there is a considerable range in the recovery per ton of coal charged. The yield ranged in 1922 from 4 to 13.3 gallons at the plants reporting the highest yield (Table 63). Yields as low as 7 gallons and as high as 10 gallons per ton of coal charged were commonly reported, and the average for the entire country was 8 gallons. The factors controlling the yield of tar were discussed in the report for 1921.[10]

Stocks of tar at the end of 1922, shown in the last column of Table 62, were reported by the producers to be 21,525,140 gallons. This was equivalent to the output for about three weeks.

[10] U. S. Geol. Survey Mineral Resources, 1921, pt. 2, pp. 423–425, 1924.

TABLE 62.—*Coke-oven tar produced and sold in the United States in 1922.*

State.	Produced (gallons).		Sold.			Used (gallons).			On hand Dec. 31 (gallons).
	Total.	Per ton of coal coked.	Gallons.	Value.		As fuel under boilers.	In open-hearth or affiliated plants.	Otherwise.	
				Total.	Average.				
Alabama	43,751,875	8.6	26,034,369	$687,803	$0.026	61,242	17,237,418	43,810	2,372,925
Colorado	5,351,500	10.1	8,210	(a)	(a)		5,339,219	27.520	52,969
Illinois	23,308,607	8.1	19,285,648	842,976	.044		3,678,717	234,514	1,551,716
Indiana	32,700,049	5.9	3,219,701	134,868	.042		29,251,292		3,158,885
Kentucky	4,414,753	7.0	4,552,289	152,812	.034				79,935
Maryland	5,557,732	6.9	3,191,119	(a)	(a)		1,518,504		1,199,673
Massachusetts	3,927,908	6.5	4,429,850	(a)	(a)	307,282			812,527
Michigan	11,572,705	7.3	4,029,615	170,412	.042	4,985,205		3,083,400	1,440,719
Minnesota	5,133,629	7.5	4,335,707	153,875	.035		435,740	74,077	375,586
New Jersey	9,416,538	8.7	9,400,705	(a)	(a)				418,064
New York	18,877,141	8.5	18,082,207	705,891	.039		988,953	45,214	1,248,938
Ohio	57,863,721	8.1	32,069,615	1,533,890	.048		25,261,587	59,292	3,153,820
Pennsylvania	89,374,955	8.6	17,888,263	692,933	.039	4,760,073	67,884,666	7,553	4,185,807
Tennessee	323,987	8.7	212,722	5,211	.024				111,265
Washington	59,203	6.3	81,106	5,596	.069				2,545
West Virginia	6,777,997	8.9	6,104,146	244,171	.040		202,447		642,504
Missouri, Rhode Island, and Wisconsin	9,367,414	8.3	9,279,145	403,495	.043				717,262
Undistributed				685,810	.040				
	327,779,734	8.0	162,204,417	6,419,743	.040	10,113,802	151,798,543	[b] 3,575,380	21,525,140

[a] Included under "Undistributed."

[b] Includes 245,828 gallons reported as "refined at plant."

TABLE 63.—*Yield of tar from coke-oven plants in 1921 and 1922.*

	1921	1922
Total production of tar.....gallons..	253,051,649	327,779,734
Yield obtained per ton of coal coked:		
At plant reporting minimum average yield.....do....	5.1	4.0
At plant reporting maximum average yield.....do....	17.0	13.3
At average plant [a].....do....	8.8	8.1
Average yield for all coal coked [b].....do....	8.8	8.0
Total number of plants producing tar	67	64
Number producing—		
Less than 7 gallons of tar per ton of coal	11	14
7–7.99 gallons	12	15
8–8.99 gallons	11	12
9–9.99 gallons	16	15
10–10.99 gallons	9	6
11–11.99 gallons	4	
12 gallons or more	4	2

[a] Sum of averages for all plants divided by number of plants.
[b] Total tar recovered at all plants divided by number of tons of coal coked.

That the large increments in the supply of tar during recent years have been absorbed without depressing the price is shown by the course of the average receipts per gallon sold, which rose from 2.5 cents in 1913 to 4.2 cents in 1921 (fig. 50). The average receipts in 1922 were 4 cents a gallon.

It is doubtful if even this average equals the true market value of the tar, because, as indicated by Table 64, the average is depressed by the inclusion of a number of plants reporting very low values. Clearly not all the sales here reported are commercial transactions; some of them represent deliveries to a financially affiliated corporation at nominal values. The figure most commonly reported is from 4 to 5 cents a gallon, and twelve plants received an average above 5 cents a gallon.

TABLE 64.—*Unit value of tar sold in 1921 and 1922.*

	1921	1922
Total receipts from sales of tar	$5,645,309	$6,419,743
Average receipts per gallon:		
At plant reporting maximum average receipts	$0.150	$0.105
At plant reporting minimum average receipts	.013	.013
At average plant [a]	.045	.041
Average for all tar sold [b]	.042	.040
Number of plants reporting sales of tar	62	58
Number of plants receiving—		
Less than 2 cents a gallon	1	1
2–2.99 cents	4	6
3–3.99 cents	17	19
4–4.99 cents	19	20
5–5.99 cents	15	8
6–6.99 cents	4	3
7 cents or more	2	1

[a] Sum of averages for all plants divided by number of plants.
[b] Total sum of sales divided by number of gallons sold.

Market prices of tar are not quoted in the trade journals, like those of other coke-oven by-products, for the reason that so large a part of the output is not sold and that the portion sold moves largely on contract or through customary connections.

AMMONIA AND ITS COMPOUNDS.

In the distillation of coal part of the nitrogen present in the raw coal is converted into ammonia and passes off with the crude gas. It may be removed by washing the gas with water or by bubbling it through diluted solutions of sulphuric acid. The first method of recovery yields ammonia liquor, which is then concentrated and may subsequently be distilled with lime for the recovery of ammonia. The content of NH_3 in the ammonia liquor produced at the coke-oven plants in 1922 was 50,730,000 pounds, equivalent to 22½ per cent of the total quantity of ammonia in all forms recovered. The second method of recovery yields ammonium sulphate directly and is known as the "direct-recovery process." It has become the commonest method of recovery of ammonia in the manufacture of by-product coke, and in 1922 77½ per cent of the ammonia produced was obtained in this way. The quantity of sulphate produced as such was 696 million pounds, and the total quantity of ammonia in all forms was equivalent to 898 million pounds of sulphate. Table 65 shows the quantities of sulphate and liquor (NH_3 content) produced in each State.

TABLE 65.—*Ammonia produced at coke-oven plants in the United States in 1922, in pounds.*

State.	Sulphate.	Liquor (NH_3 content).	Sulphate equivalent of all forms.	
			Total.	Per ton of coal coked.
Alabama	93,815,966	5,951,287	117,621,114	23.0
Colorado	11,253,423		11,253,423	21.3
Illinois	40,736,307	5,672,267	63,425,375	22.0
Indiana	61,809,741	7,293,125	90,982,241	16.5
Kentucky	12,948,885		12,948,885	20.6
Maryland	15,920,250		15,920,250	19.9
Massachusetts	11,360,000		11,360,000	18.7
Michigan	17,384,650	5,072,452	37,674,458	23.9
Minnesota	9,373,979	1,220,451	14,255,783	20.7
New Jersey	20,774,000	1,273,666	25,868,664	23.8
New York	23,043,299	[a] 6,958,408	50,876,931	23.0
Ohio	138,175,500	6,063,951	162,431,304	22.8
Pennsylvania	219,802,169	[a] 4,389,424	237,359,865	22.9
Tennessee	793,172		793,172	21.4
Washington		67,283	269,132	28.7
West Virginia	18,352,008	122,240	18,840,968	24.9
Missouri, Rhode Island, and Wisconsin		6,645,874	26,583,496	23.6
	695,543,349	[a] 50,730,428	898,465,061	21.9

[a] Includes a small amount of "other forms" of ammonia.

The average yield of ammonia in 1922, including all forms recovered, was equivalent to 21.9 pounds of sulphate per net ton of coal charged. The decrease in average recovery from 1921, when a yield of 22.8 pounds per ton of coal coked was recorded (Table 66, fig. 51), was due in part to the unfavorable operating conditions of 1922 and to the necessity of accepting, at times, inferior coal. A wide range exists between the highest and lowest yields. As shown in Table 66, there were three plants in 1922 that reported an average recovery of over 28 pounds of sulphate per ton of coal. Two other plants obtained an average yield of less than 15 pounds. The yield most commonly reported was from 22 to 24 pounds.

TABLE 66.—*Yield of ammonium sulphate equivalent reported by coke-oven plants in 1921 and 1922.*

	1921	1922
Total ammonium sulphate or equivalent recovered.....pounds..	657,001,003	898,465,061
Yield of sulphate per ton of coal coked:		
At plant reporting minimum average yield.....do....	3.6	14.2
At plant reporting maximum average yield.....do....	30.3	29.9
At average plant [a].....do....	21.9	22.1
Average yield for all coal coked [b].....do....	22.8	21.9
Total number of plants reporting recovery of ammonia	67	64
Number of plants recovering—		
Less than 10 pounds per ton of coal	2	
10–14.9 pounds	2	2
15–19.9 pounds	14	14
20–21.9 pounds	11	13
22–23.9 pounds	13	17
24–25.9 pounds	15	10
26–27.9 pounds	3	5
28–29.9 pounds	6	3
30 pounds or more	1	

[a] Sum of averages for all plants divided by number of plants.
[b] Total yield in sulphate equivalent divided by number of tons of coal carbonized.

Slightly more ammonia was sold in 1922 than was produced, the difference being withdrawn from stock. About 78 per cent of the material sold was in the form of sulphate, and the total quantity of sulphate sold was 715,000,000 pounds. The liquor sold had a content of 48,524,000 pounds of NH_3. Included in this figure, however, is a small amount of ammonium chloride sold. No plant reported either the production or sale of anhydrous ammonia in 1922. The sales of ammonia by States are given in Table 67.

The stocks on hand December 31, 1922, were reported as 45,414,493 pounds of sulphate and 3,281,198 pounds of NH_3 in ammonia liquor and other compounds. The stocks of sulphate thus represented between 6 and 7 per cent of the annual production, and the stocks of ammonia in other forms were equivalent to a like percentage of the annual production of those forms.

TABLE 67.—*Ammonia sold by coke-oven plants in the United States in 1922.*

State.	Sulphate.			Liquor (NH_3 content).			Total (sulphate equivalent of all forms).	
	Pounds.	Value.		Pounds.	Value.		Pounds.	Value.
		Total.	Average.		Total.	Average.		
Alabama	92,529,632	$2,474,706	$0.027	6,192,891	$580,151	$0.094	117,301,196	$3,054,857
Colorado	11,137,450	[a]	[a]				11,137,450	[a]
Illinois	43,606,220	1,135,416	.026	5,272,715	570,923	.108	64,697,080	1,706,339
Indiana	63,916,593	1,278,263	.020	7,052,298	644,283	.091	92,125,785	1,922,546
Kentucky	13,385,409	325,570	.024				13,385,409	325,570
Maryland	15,398,610	[a]	[a]				15,398,610	[a]
Massachusetts	11,568,600	[a]	[a]				11,568,600	[a]
Michigan	11,356,551	265,371	.023	4,912,455	640,928	.130	31,006,371	906,299
Minnesota	8,819,207	232,688	.026	1,232,519	119,152	.097	13,749,283	351,840
New Jersey	21,700,000	[a]	[a]	1,273,666	[c]	[c]	26,794,664	[d]
New York	24,525,314	632,304	.026	[b] 6,805,425	559,448	.082	51,747,014	1,191,752
Ohio	154,055,689	3,887,814	.025	5,520,683	500,813	.091	176,138,421	4,388,627
Pennsylvania	221,990,855	5,368,352	.024	[b] 3,690,901	282,918	.077	236,754,459	5,651,270
Tennessee	658,000	20,985	.032				658,000	20,985
Washington				69,437	6,205	.089	277,748	6,205
West Virginia	20,104,752	526,391	.026	90,146	7,926	.088	20,465,336	534,317
Missouri, Rhode Island, and Wisconsin				6,410,801	[c] 646,788		25,643,204	[d] 646,788
Undistributed		1,670,376	.028					1,670,376
	714,752,882	17,818,236	.025	48,523,937	4,559,535	.094	908,848,630	22,377,771

[a] Included under "Undistributed."
[b] Includes a small quantity of "other forms" of ammonia.
[c] New Jersey value included with that of Missouri, Rhode Island, and Wisconsin.
[d] Value of New Jersey sulphate included under "Undistributed" and value of liquor with total for Missouri, Rhode Island, and Wisconsin.

The average receipts from sales in 1922 were almost exactly the same as in 1921 and amounted to 2.5 cents per pound of sulphate and 9.4 cents per pound of NH_3 in liquor. The average receipts from all sales since 1918 have been as follows (see also fig. 50): 1918, 4.5 cents; 1919, 3.8 cents; 1920, 4.3 cents; 1921, 2.5 cents; 1922, 2.5 cents.

The average receipts of individual plants ranged from 1.8 to 3.2 cents per pound of sulphate. There were, however, fewer sales at "distress prices" than in 1921, when the market was burdened with heavy stocks held over from the year before. (See Table 68.)

The market price of ammonia fluctuates with those of other fertilizer materials. A large part of the liquor produced in this country from both coke-oven and coal-gas plants is consumed in the manufacture of explosives and in the refrigeration industry. The total quantities produced, however, so far exceed the consumption for these purposes that the principal outlet is the fertilizer trade. Figure 56 shows the close correspondence between the price of ammonium sulphate and of Chile nitrate, both in New York. Prices of fertilizers have shared in the depression suffered by agriculture in general since 1920. In 1921 they dropped to the lowest point of record for many years, though because of contracts the producers were not compelled to sell all their output at the spot-price level.

Distinct improvement in the sulphate market was felt in 1922, however. A reviving demand at home and for export was quickened by the shortage created in midsummer when the combined effect of the coal and railroad strikes forced curtailment of by-product oven operation. Exports were fairly active in the early part of the year but later dropped off.

TABLE 68.—*Unit value of ammonium sulphate sold in 1921 and 1922.*

	1921	1922
Total sales of sulphate ..... pounds	530,041,716	714,752,882
Total value of sales	$13,100,703	$17,818,236
Average receipts per pound:		
At plant reporting minimum average receipts	$0.015	$0.018
At plant reporting maximum average receipts	.036	.032
At average plant [a]	.029	.027
Average for all sulphate sold [b]	.025	.025
Total number of plants reporting sales of sulphate	51	40
Number of plants receiving—		
Less than 2 cents a pound	4	1
2–2.19 cents	2	1
2.2–2.39 cents	4	4
2.4–2.59 cents	11	8
2.6–2.79 cents	14	15
2.8–2.99 cents	12	5
3.0 cents or more	4	6

[a] Sum of averages for all plants divided by number of plants.
[b] Total value of sales divided by number of pounds sold.

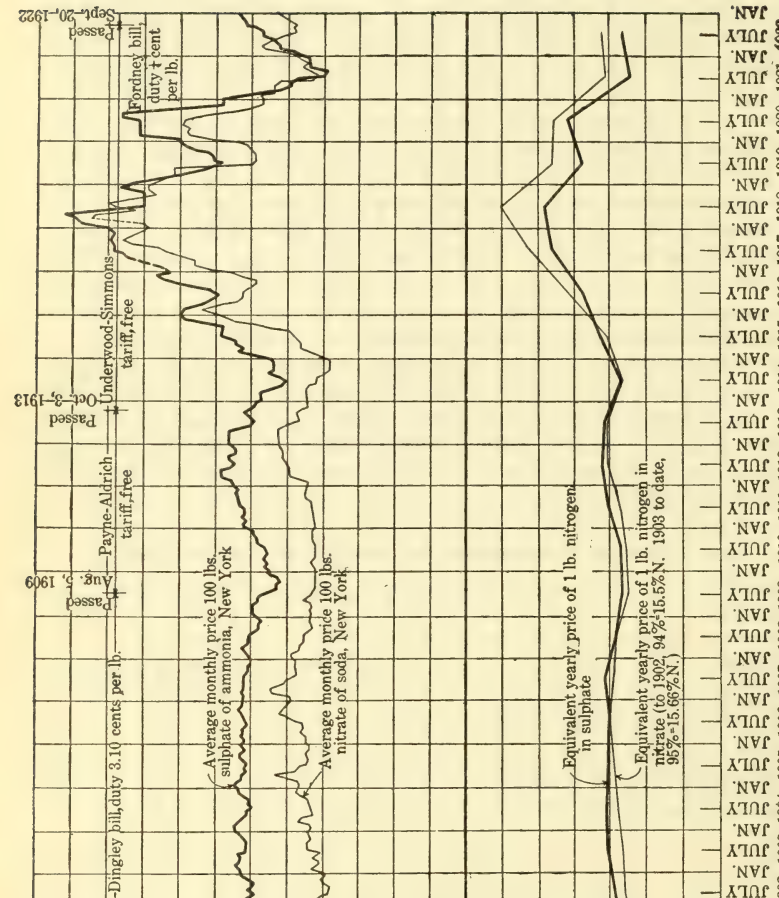

FIGURE 56.—Monthly prices of sulphate of ammonia and nitrate of soda and equivalent yearly price per pound of nitrogen in each, 1901-1922.

The quotations on sulphate of ammonia up to 1917 are spot prices in New York, taken from the Engineering and Mining Journal for 1901 and 1902, and from the Oil, Paint, and Drug Reporter from 1903 to 1916. Beginning with 1917 they represent producers' prices f. o. b. works, as quoted by the Iron Trade Review. The straight lines at the bottom represent the equivalent yearly prices of 1 pound of nitrogen, counting sulphate as 20.56 per cent nitrogen and the nitrate as 15.5 per cent nitrogen for the years 1901 to 1902 and as 15.66 per cent nitrogen for the years 1903 to 1922. (Adapted from chart furnished by courtesy of the Barrett Co.)

TABLE 69.—*Average monthly prices of sulphate of ammonia per 100 pounds, 1909–1923.*

[Quotations, 1909–1916, abstracted from Oil, Paint, and Drug Reporter, at New York; 1917 to date, from Iron Trade Review, f. o. b. producers' works. Compiled by C. G. Atwater, of the Barrett Co.]

	1909	1910	1911	1912	1913	1914	1915	1916
January	$2.91	$2.73	$2.97½	$3.20¾	$3.28	$2.90	$2.71¼	$3.96½
February	2.99	2.73¾	3.08¾	3.24¼	3.30	2.85	2.98¾	3.96¼
March	2.98¼	2.83¾	3.11¼	3.28	3.30	2.85	3.16	3.92½
April	2.97¼	2.77	3.11¼	3.38	3.30	2.85	3.10⅝	3.68¾
May	2.91	2.82	3.07½	3.40	3.30	2.70	3.20	3.57½
June	2.90	2.78¾	3.03¾	3.40	3.12	2.55	3.22½	3.53
July	2.88	2.78¾	3.07¼	3.25	3.00	2.52	3.41	3.43½
August	2.75½	2.79¼	3.16¼	3.22½	2.98	2.60	3.53	3.58¾
September	2.65	2.87½	3.16¼	3.29	3.07	2.76⅞	3.37½	3.77½
October	2.65	2.92½	3.18	3.28	3.10	2.67½	3.37½	4.02½
November	2.62½	2.93¾	3.18	3.20⅝	3.06¼	2.67½	3.57	4.21¼
December	2.64	2.96¼	3.20	3.22½	2.95	2.67½	3.93¾	4.32½
Average	2.82	2.83	3.11	3.28	3.14	2.71	3.30	3.83

	1917	1918	1919	1920	1921	1922	1923
January	$4.12	$5.03	$4.68	$4.00	$3.37½	$2.20	$3.10
February	4.18	5.22½	4.50	4.00	3.12½	2.35	3.15⅝
March	[a]	5.40½	4.25	4.55	2.92½	2.60½	3.19½
April	[a]	5.46	4.00	4.55	2.57½	2.65	3.22½
May	4.72½	5.59½	3.80	4.55	2.45	2.67	3.21½
June	4.80	5.10	3.60	4.55	2.45	2.72	3.13¾
July	4.90	4.50	3.40	4.55	2.35	2.82	3.10
August	4.90	4.50	3.53	4.80	2.00	2.82	3.07½
September	4.92½	4.50	3.53	4.80	1.95	2.90	3.02½
October	4.95	4.50	3.57	4.25	2.20	3.05	3.01¼
November	4.92½	4.50	3.78	3.75	2.20	3.07	2.93¾
December	4.90	4.86	3.93	3.38	2.20	3.12	2.76¼
Average	4.73	4.93	3.88	4.31	2.48	2.75	3.08

[a] No market.

LIGHT OIL AND ITS DERIVATIVES.

BENZOL AND RELATED PRODUCTS.

The World War created a great supply of toluol, benzol, and related products in the United States. With the end of the war the price of toluol dropped even more precipitately than it had risen. The flood of light-oil derivatives that had been poured into the manufacture of explosives now sought an outlet elsewhere. The new outlet was the market for motor fuel.

The change was marked both by a shrinkage in the revenue derived from light oil and by a shift in the immediate source of that revenue. Toluol, though obtainable from light oil in the ratio of only 1 part toluol to 5 parts benzol, had furnished in 1918 nearly half of the receipts from sales of the light-oil products. Out of the total receipts in 1918 from sales of light oil and its derivatives, amounting to 99 cents per ton of coke (fig. 49), 48 cents had been contributed by toluol, as against only 47 cents for the much larger quantity of benzol. Under the conditions of 1922 the production of the toluol fraction was curtailed and that of the benzol fraction increased. Toluol receipts averaged only 2 cents per ton of coke, while the benzol, including motor fuel, produced 54 cents.

Motor benzol recovered from light oil stripped from coke-oven gas had been sold by one producer before the European war. With the collapse of the munitions demand all producers now turned to this outlet. Refining practice was altered to produce larger proportions

of motor benzol, and some producers even undertook blending with gasoline on their own account. To some extent the other fractions were allowed to remain in the motor benzol. This fact and the possibility of a certain interplay between them has kept the prices of the three principal fractions—toluol, benzol, and solvent naphtha—at a common level since 1919, as shown in Figure 58. The prices for these three derivatives have tended to fluctuate in sympathy and have come to rest at about the same level—namely, from 25 to 35 cents a gallon. Between them there is normally a differential of a few cents, the price of toluol being ordinarily the highest, benzol next, and solvent naphtha the lowest. This is, of course, in sharp contrast with the conditions during the war, when the average receipts from sales of toluol rose to ten times those from solvent naphtha and four times those from benzol. (See Table 58, p. 760.) In fact, the excessive demand for toluol created a surplus of solvent naphtha, the prices of which in 1917 and 1918 were lower than those prevailing to-day. The present relation between the three is much the same as that which prevailed before the war, when the average spot price of benzol (27 cents in 1913) was about 2 cents below that of toluol and 2 cents above that of solvent naphtha.

The dominant influence shaping the price of benzol since the armistice was signed has of course been the price of gasoline. Benzol and toluol, sometimes designated benzene and toluene, are in increasing demand for the manufacture of dyes and other organic chemicals and as solvents in paints and varnishes, but the consumption for these purposes is small compared with the demand for automotive fuel. Some of the "benzol," including toluene, is sold direct by the producer, either raw or blended with gasoline, and some is sold to petroleum refiners for blending. Benzolated gasoline at retail commands a premium of a few cents a gallon over the retail price of gasoline.

Figure 57 compares the course of retail gasoline prices represented by the average tank-wagon price in the five cities of New York, Baltimore, Chicago, Kansas City, and San Francisco, compiled by Joseph E. Pogue, with that of benzol prices as quoted in the trade journals. The solid black line of the diagram is the spot price in New York of 90 per cent benzol as quoted by the Oil, Paint, and Drug Reporter. The uppermost line of the chart represents the price of pure benzol f. o. b. works quoted by the producer, as reported in the Iron Trade Review. The producer's price follows rather closely the tank-wagon gasoline price. It is subject to less sharp fluctuations than the spot price, because it represents the efforts of the producer to stabilize prices by cultivating a permanent market. The spot price of 90 per cent benzol in New York also shows general conformity to the gasoline price, except that it responds to other factors affecting the market at the moment. Thus the combined influence of the steel and coal strikes of late 1919 is shown in a sharp temporary increase in the spot price at New York. The quantities actually changing hands at these higher prices were small, but contemporary market quotations show a distinct shortage of spot benzol available either for export or for domestic consumption. The increase was followed by a temporary reaction as greater production of coke brought out larger supplies of benzol. During the same time the producers showed a disposition to hold to their regular prices and give preference to

deliveries on commitments rather than to sell on the spot market. Except for the first few months of 1919, when the market was depressed by heavy stocks accumulated during the war, there has been no period of any length when prices of both pure and 90 per cent benzol were not considerably above the gasoline price, and this relation is likely to continue.

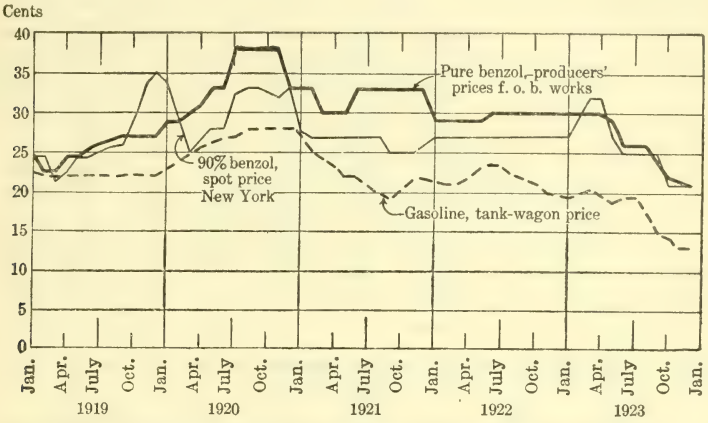

FIGURE 57.—Spot price of 90 per cent benzol in New York, producers' price of pure benzol f. o. b. works, and tank-wagon price of gasoline, 1919–1923.

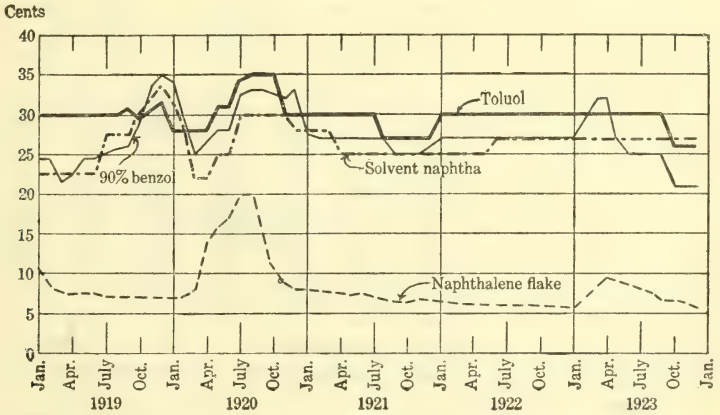

FIGURE 58.—Spot prices of 90 per cent benzol, toluol, solvent naphtha, and flake naphthalene in New York, 1919–1923.

TABLE 70.—*Producers' price per gallon of pure benzol f. o. b. works and tank-wagon price of gasoline, by months, 1919–1922.*

[Prices of benzol are those quoted by Iron Trade Review; of tank-wagon gasoline, average for five cities, computed by J. E. Pogue.]

Month.	1919		1920		1921		1922	
	Benzol.	Gasoline.	Benzol.	Gasoline.	Benzol.	Gasoline.	Benzol.	Gasoline.
January	$0.245	$0.225	$0.290	$0.231	$0.330	$0.276	$0.290	$0.214
February	.225	.222	.290	.237	.330	.250	.290	.211
March	.225	.222	.300	.251	.300	.240	.290	.211
April	.245	.222	.310	.259	.300	.236	.290	.217
May	.245	.222	.330	.262	.300	.220	.290	.230
June	.255	.222	.330	.268	.330	.214	.290	.235
July	.260	.222	.380	.268	.330	.206	.300	.236
August	.265	.222	.380	.275	.330	.201	.300	.222
September	.270	.222	.380	.281	.330	.193	.300	.221
October	.270	.222	.380	.281	.330	.201	.300	.213
November	.270	.222	.380	.279	.330	.214	.300	.200
December	.270	.222	.330	.278	.330	.218	.300	.198
Average	.254	.222	.340	.265	.323	.223	.295	.217

TABLE 71.—*Monthly spot prices of coal-tar products in New York market, by months, 1919–1922.*

[As quoted by Oil, Paint and Drug Reporter. Figures are averages of high and low quotations for each month.]

Month.	Benzol (90 per cent), per gallon.				Toluol, per gallon.			
	1919	1920	1921	1922	1919	1920	1921	1922
January	$0.245	$0.340	$0.275	$0.270	$0.300	$0.280	$0.300	$0.300
February	.245	.295	.270	.270	.300	.280	.300	.300
March	.215	.250	.270	.270	.300	.280	.300	.300
April	.225	.265	.270	.270	.300	.280	.300	.300
May	.245	.280	.270	.270	.300	.310	.300	.300
June	.245	.280	.270	.270	.300	.310	.300	.300
July	.253	.325	.270	.270	.300	.345	.300	.300
August	.258	.330	.270	.270	.300	.350	.270	.300
September	.260	.330	.250	.270	.305	.350	.270	.300
October	.290	.325	.250	.270	.295	.350	.270	.300
November	.335	.320	.250	.270	.305	.300	.270	.300
December	.350	.330	.260	.270	.315	.300	.270	.300
Average	.264	.306	.265	.270	.302	.311	.288	.300

Month.	Solvent naphtha, per gallon.				Naphthalene flakes, per pound.			
	1919	1920	1921	1922	1919	1920	1921	1922
January	$0.225	$0.320	$0.280	$0.250	$0.105	$0.070	$0.079	$0.065
February	.225	.285	.280	.250	.082	.070	.080	.065
March	.225	.220	.280	.250	.077	.081	.077	.062
April	.225	.220	.250	.250	.072	.139	.077	.062
May	.225	.250	.250	.250	.075	.160	.072	.061
June	.225	.250	.250	.270	.075	.170	.075	.062
July	.275	.300	.250	.270	.072	.200	.071	.061
August	.275	.300	.250	.270	.070	.200	.069	.060
September	.275	.300	.250	.270	.070	.152	.066	.060
October	.300	.300	.250	.270	.070	.107	.065	.060
November	.325	.300	.250	.270	.072	.090	.067	.059
December	.335	.280	.250	.270	.072	.081	.067	.057
Average	.261	.277	.258	.262	.076	.127	.072	.061

As motor fuel has become the principal outlet for light-oil derivatives, it is of interest to inquire what are the possibilities of expansion in this direction. In Figure 59 the production of gasoline and that of benzol are compared. Thus in 1922 the total output of benzol of all grades and from all sources, including motor benzol, was 71 million gallons, as against 6,202 million gallons of gasoline from petroleum refineries and 506 million gallons of gasoline extracted from natural gas. The expanding output of benzol is thus still but 1 per cent of the production of gasoline from other sources. Indeed were all the soft coal now produced annually to be carbonized and treated

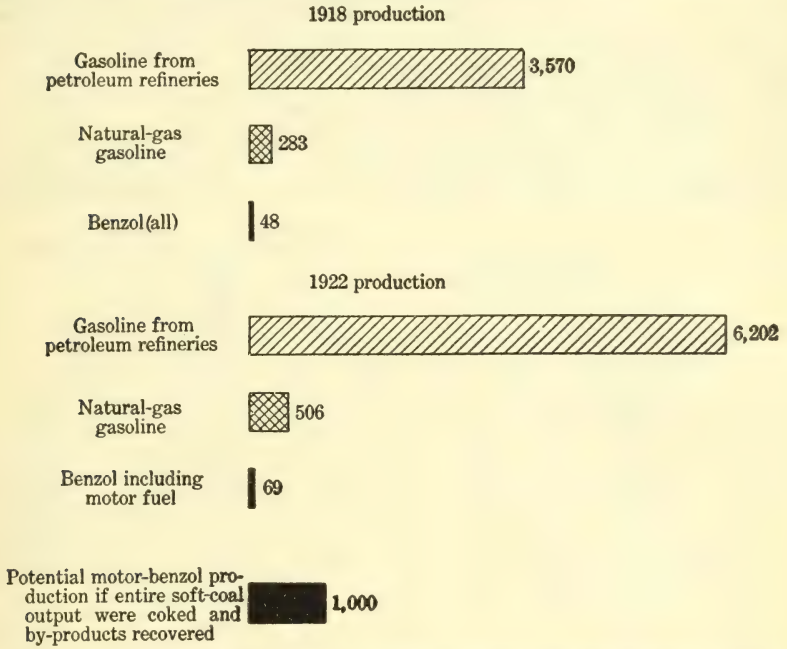

FIGURE 59.—Production of gasoline and benzol in 1918 and 1922 and potential production of benzol if entire output of coal were treated for by-products. Figures represent millions of gallons.

for recovery of the by-products the quantity of motor benzol recovered would probably not exceed 1,000 million gallons—barely one-sixth of the present production of gasoline from petroleum. This quantity, represented by the black bar at the bottom of the diagram, is far less than the increase in the production of gasoline from 1918 to 1922. In view of the expanding gasoline requirements of the country and the probability of decreasing supplies of crude petroleum, there appears no doubt that the markets will absorb all the benzol that can be produced, at a price that will depend upon the ruling price of gasoline.

TABLE 72.—*Production of motor fuel in the United States, 1918–1922, in gallons.*

Year.	Gasoline production of petroleum refineries.[a]	Natural-gas gasoline (total production).[b]	Benzol produced, all grades, including motor benzol.		
			Coke ovens.	Gas works, including oil and water gas.	Tar refineries, etc.[c]
1918	3, 570, 000, 000	283, 000, 000	44, 805, 000	[d] 5, 633, 000	3, 015, 000
1919	3, 958, 000, 000	352, 000, 000	61, 068, 000	(e)	1, 826, 000
1920	4, 883, 000, 000	385, 000, 000	72, 994, 000	[f] 502, 000	876, 000
1921	5, 154, 000, 000	450, 000, 000	54, 459, 000	(e)	2, 172, 000
1922	6, 202, 000, 000	506, 000, 000	70, 112, 000	(g)	[h] 775, 000

[a] From Bureau of Mines Refinery Statistics for 1923, by W. C. Hill.
[b] From reports of producers to the Geological Survey.
[c] As reported to the U. S. Tariff Commission.
[d] Of this only 2,177,000 gallons was sold, the balance being returned to the gas.
[e] Data not available in comparable form.
[f] Quantity sold, used because of apparent double counting between production figures of crude and refined benzol.
[g] Can not be shown without disclosing individual returns.
[h] Does not include a small amount of motor benzol which can not be shown without disclosing individual returns.

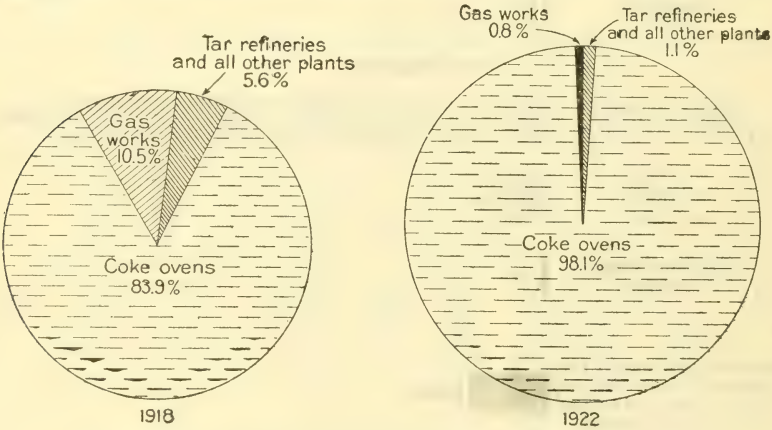

FIGURE 60.—Production of benzol of all grades by sources, 1918 and 1922.

Coincident with the collapse of benzol prices since the war has come a shift in the sources of supply. (See Table 72 and fig. 60.) In 1918 16.2 per cent of the benzol produced in the United States came from gas works, tar refineries, and plants cracking crude petroleum, and the share contributed by coke ovens was 83.8 per cent. Five years later all but a very few of the gas plants had withdrawn from the benzol market, the production of coke ovens had risen to 98.5 per cent of the total output, and all other sources combined yielded but 1.5 per cent. The considerable output of benzol by the gas works in 1918—5,633,000 gallons, or 10.5 per cent of the total—was essentially a by-product of the recovery of toluol, which was at once stimulated by the high prices and permitted by the relaxation of standards of heating value and candle power by public-utility commissions. Even at that time the greater part of the benzol produced by gas plants was returned to enrich the gas, and the sales of benzol as such in 1918 from this source amounted to only

2,177,000 gallons. By 1922 benzol recovery had been discontinued by all but two gas companies and the production from this source had fallen to less than 1 per cent of the country's output.

The same tendency has extended to the by-product coke industry, where plants that furnish gas for city supply have largely ceased to strip the gas and recover benzol, either because of the more exacting standards required by public utilities or because the benzols bring better prices when sold as a rich gas than when extracted and sold as separate products. Thus in 1922 only 53 of the 64 coke plants in operation recovered crude light oil, a decrease of 4 plants when compared with the year before (Table 73). The 11 plants that produced coke but did not recover light oil are in or near Chicago, Boston, Detroit, Newark, Syracuse, Providence, Seattle, and Philadelphia. Of the 53 plants that recovered crude light oil, 12, including the properties operated by the Semet-Solvay Co., did not attempt to refine the crude oil on the premises. Of the 41 plants that made any refined product, 40 reported the manufacture of motor benzol, indicating again the dominance now attained by this light-oil derivative.

TABLE 73.—*Number of plants making light oil or derivatives in 1921 and 1922.*

State.	1921				1922			
	Total making coke.	Making crude light oil.	Making any refined product.	Making motor benzol.	Total making coke.	Making crude light oil.	Making any refined product.	Making motor benzol.
Alabama	7	7	4	4	7	7	5	5
Colorado	1	1	1	1	1	1	1	1
Illinois	7	4	2	2	6	4	3	3
Indiana	6	5	5	5	6	5	5	5
Kentucky	1	1			1	1		
Maryland	1	1	1	1	1	1	1	1
Massachusetts	1				1			
Michigan	3	2	1	1	3	2	1	1
Minnesota	3	3	3	3	3	3	2	2
Missouri	1	1	1		1	1	1	1
New Jersey	2	1	1	1	2			
New York	5	4	3	3	5	4	3	3
Ohio	10	10	7	7	11	11	8	7
Pennsylvania	11	11	6	6	9	8	7	7
Rhode Island	1				1			
Tennessee	1	1	1		1	1	1	1
Washington	1				1			
West Virginia	3	3	2	2	3	3	2	2
Wisconsin	2	2	2	2	1	1	1	1
	67	57	40	38	64	53	41	40

The outstanding features of the market for light-oil products in 1922 were steady prices but highly unsettled conditions of production. As shown in the curves of Figure 58, prices of pure benzol and solvent naphtha advanced slightly in June, when apprehension of possible curtailment of production as a result of the coal strike was apparent in the trade. The increase in prices seems hardly proportionate to the dislocation in supply that must have resulted from the curtailment of oven operation in July, August, and September. The by-product plants were operating in June at 69.2 per cent of maximum capacity and in August had dropped to 48.2 per cent. Trade reports indicate that during the third quarter it was impossible for sellers to meet their requirements. Greater production toward the end of the

year, when the ovens reached 82.2 per cent of capacity, was fortunately accompanied by a greater demand. Imports of benzol in 1922 were insignificant. Exports reached the total of 64,740,000 pounds, equivalent to 9,417,000 gallons, the largest figure recorded except in 1921.

The quantity of benzol in various forms produced and sold in each State is given in Table 74. The crude benzol produced amounted to 2,666,000 gallons, practically all of which was sold, the average price being 26.2 cents. Sales of refined benzol were nearly four times as large and yielded an average of 28.5 cents. The great bulk of the benzol, as in 1921, was sold as motor fuel or "motor benzol." Sales of this product were reported as 54,930,000 gallons, or about four-fifths of the total quantity of benzol in all forms that was sold. The average receipts per gallon of motor benzol were 19.1 cents, as against 17.9 cents in 1921.

TABLE 74.—*Benzol produced and sold in the United States in 1922, by States.*

State.	Produced (gallons).	Sold.		
		Gallons.	Value.	
			Total.	Average.
Crude benzol:				
Alabama	86,104	84,939	$21,250	$0.250
Colorado		5	1	.200
Illinois				
Indiana				
Maryland				
Michigan				
Minnesota				
New York	1,810,381	1,840,351	479,610	.261
Ohio	578,514	550,877	144,057	.261
Pennsylvania				
Tennessee				
West Virginia				
Missouri and Wisconsin	191,178	189,717	53,519	.282
	2,666,177	2,665,889	698,437	.262
Refined benzol:				
Alabama	65,307	80,980	19,695	.243
Colorado	150,932	141,661	39,665	.279
Illinois	69,096	69,096	13,819	.200
Indiana	491,840	416,654	114,254	.274
Maryland				
Michigan				
Minnesota	89,691	90,804	19,678	.217
New York	2,720,245	2,707,334	770,505	.285
Ohio	3,568,578	3,270,722	917,003	.280
Pennsylvania	2,134,407	1,707,838	537,853	.315
Tennessee				
West Virginia	61,711	61,711	17,423	.282
Missouri and Wisconsin	1,067,697	1,043,659	287,049	.275
	10,419,504	9,590,459	2,736,944	.285
Motor benzol:				
Alabama	8,660,784	8,504,741	1,459,830	.172
Colorado	740,665	576,733	(a)	(a)
Illinois	2,210,970	2,090,310	365,906	.175
Indiana	9,645,783	9,352,797	1,690,200	.181
Maryland	909,579	735,724	(a)	(a)
Michigan	880,428	814,589	254,987	.313
Minnesota	402,551	376,647	61,696	.164
New York	3,962,602	3,810,245	794,685	.209
Ohio	9,111,588	8,883,971	1,808,032	.204
Pennsylvania	18,667,516	18,083,908	3,458,641	.191
Tennessee	45,694	26,634	3,595	.135
West Virginia	1,787,204	1,673,164	339,913	.203
Missouri and Wisconsin	335	740	162	.219
Undistributed			253,662	
	57,025,699	54,930,203	10,491,309	.191

[a] Included under "Undistributed."

It is evident from the prices received that the interpretation placed upon the terms "crude benzol," "refined benzol," and "motor benzol" by the operators reporting has not been uniform. The trade meaning of these terms differs in different parts of the country, and the Geological Survey has not undertaken to lay down precise standards to be followed by operators in making their returns on these commodities. Each operator has therefore recorded his production under the name locally accepted. The discrepancies that may result from these varying definitions are not of great consequence, for the products are largely interchangeable in use.

In Table 75 appear the returns on production and sales of toluol and solvent naphtha.

TABLE 75.—*Toluol and solvent naphtha produced and sold in the United States in 1922, by States.*

State.	Toluol (refined).				Solvent naphtha.			
	Produced (gallons).	Sold.			Produced (gallons).	Sold.		
		Gallons.	Value.			Gallons.	Value.	
			Total.	Average.			Total.	Average.
Alabama					535,154	132,546	$19,801	$0.149
Colorado					146,326	23,799	(b)	(b)
Illinois	8,381	8,381	$2,514	$0.300	60,583	56,827	10,745	.189
Indiana	32,336	24,558	7,576	.308	195,874	112,468	26,895	.239
Maryland					12,819	10,076	(b)	(b)
Minnesota					3,614	16,510	2,347	.142
New York	693,940	703,870	204,518	.291	429,996	414,896	79,903	.193
Ohio	a 443,873	383,181	111,828	.292	416,092	366,229	82,618	.226
Pennsylvania	419,511	383,857	113,338	.295	904,492	1,427,543	250,597	.175
West Virginia	10,870	10,208	2,909	.285	85,770	84,264	15,688	.186
Missouri and Wisconsin	a 384,367	a 396,005	a 114,332	.289	193,138	216,324	42,073	.194
Undistributed							7,845	.232
	a 1,993,278	a 1,910,060	a 557,015	.292	2,983,858	2,861,482	538,512	.188

a Includes a small quantity of crude toluol. b Included under "Undistributed."

CRUDE LIGHT OIL.

The total production of crude light oil reported in 1922 (Table 76) was 101,000,000 gallons. The total quantity refined by coke-oven operators was 98,432,000 gallons. This figure, however, includes 4,200,000 gallons of purchased oil, most of which undoubtedly came from other producers of coke. In the figures of quantities refined on the premises and quantities sold, there is therefore a slight double counting, which inflates slightly the figures of total credits from the sale of by-products recorded in Table 41. The amount of the error introduced can not be exactly determined, and therefore no attempt is made to correct it. It can not exceed, however, the value of the 4,200,000 gallons of the crude light oil purchased, or say $500,000. The error in the calculated receipts from sales of by-products per ton of coke produced can not exceed 1.8 cents.

TABLE 76.—*Crude light oil produced and sold at coke-oven plants in the United States in 1922.*

State.	Produced (gallons).	Refined on the premises (gallons).	Sold.		
			Gallons.	Value.	
				Total.	Average.
Alabama	13,152,939	11,297,586			
Illinois	4,918,763	3,219,256	1,573,384	$176,536	$0.112
Indiana	13,171,996	13,178,189			
Kentucky	1,802,471		1,715,002	219,683	.128
Maryland	1,177,269	1,115,698			
Michigan	2,400,551	1,105,069			
Minnesota	616,780	614,073			
New York	6,125,359	[a] 12,991,988	435,171	64,829	.149
Ohio	21,378,621	19,062,812	1,207,033	142,181	.118
Pennsylvania	29,497,158	28,740,514	207,240	27,499	.133
Tennessee	92,905	70,025			
West Virginia	3,002,704	2,993,057			
Colorado, Missouri, and Wisconsin	4,100,039	4,043,833	265	40	.151
	101,437,555	[b] 98,432,100	5,138,095	630,768	.123

[a] Includes crude oil shipped by Solvay plants to the Syracuse refinery.
[b] Includes 4,200,000 gallons of purchased oil.

The yield of light oil per ton of coal carbonized depends to a considerable extent upon the kind of coal used and also upon the kind of coke it is desired to make. It also depends upon the efficiency of the oven and the skill of the operator. The average yield in 1922 ranged from 0.7 gallon to 4.5 gallons per ton of coal. The average for all the 53 plants that recovered light oil (not including those that produced coke but did not recover benzol products) was 2.7 gallons. As the highest annual average yet reported was 2.8 gallons, attained in 1921, it will be seen that calculations of possible production of light-oil derivatives that assume an average of 4 gallons per ton of coal, a figure that has been frequently used, are unduly optimistic for the country as a whole including new plants. Under present practice, with present equipment, such a figure represents exceptionally good rather than average performance.

TABLE 77.—*Crude light oil yields reported by coke-oven plants in 1921 and 1922.*

	1921	1922
Total recovery of crude light oil.....gallons	76,917,269	101,437,555
Recovery per ton of coal coked:		
At plant reporting minimum average yield.....do	0.09	0.7
At plant reporting maximum average yield.....do	4.0	4.5
At average plant [a].....do	2.7	2.7
Average recovery for all coal coked [b].....do	2.8	2.7
Total number of plants reporting recovery of light oil	57	53
Number of plants recovering—		
Less than 2 gallons per ton of coal	9	9
2–2.49 gallons	8	11
2.5–2.99 gallons	16	15
3–3.49 gallons	10	11
3.5–3.99 gallons	12	4
4 gallons or more	2	3

[a] Sum of averages for each plant divided by number of plants.
[b] Total crude oil recovered divided by number of tons of coal coked at plant recovering the oil.

The variations in average receipts per gallon sold, showa by Table 78, are due in part to differences between contract and spot prices, in part to differences in the skill of the sales departments of the producing companies, and chiefly to the variations in grade and specifications above referred to. The tables show the range in average receipts obtained from the products sold under these names in different parts of the country. The range in the average receipts for solvent naphtha is especially wide because of the wide variation in its chemical composition. Out of 30 plants that sold solvent naphtha in 1922 3 received less than 10 cents a gallon and 4 received more than 30 cents. The average for all solvent naphtha sold was 18.8 cents.

TABLE 78.—*Average receipts for light-oil derivatives sold during 1922.*

	Benzol.			Toluol (crude and refined).	Solvent naphtha.
	Crude.	Refined.	Motor benzol.		
Total sales.....gallons	2,665,889	9,590,459	54,930,203	1,910,060	2,861,482
Average receipts per gallon:					
At plant reporting minimum receipts	$0.150	$0.178	$0.126	$0.166	$0.060
At plant reporting maximum receipts	.283	.356	.313	.358	.346
At average plant [a]	.270	.282	.196	.309	.198
Average for all sales [b]	.262	.285	.191	.291	.188
Total number of plants reporting sales	8	27	40	15	30
Number of plants reporting receipts of—					
Less than 10 cents a gallon			1		3
10–14.9 cents			4		6
15–19.9 cents	2	1	14	1	8
20–24.9 cents		3	17		2
25–29.9 cents	6	18	2	8	7
30–34.9 cents		5	2	6	4

[a] Sum of averages for all plants divided by number of plants.
[b] Total value of sales of each product divided by number of gallons sold.

GAS.

The manufacture of coke in a by-product oven requires, of course, the application of heat. Ordinarily the heat is obtained by burning some of the gas produced in the process of distillation of the coal. The surplus gas not required in the coking process may be used elsewhere about the plant or it may be sold. Whether used or sold it furnishes an important credit against the cost of coking. As noted above the surplus gas has now become the chief source of auxiliary revenue to the operator of the by-product oven, yielding in 1922 as much as ammonia and the benzol products combined (fig. 49). Moreover, while the value of the other by-products has declined since the war or at best remained stationary, the value of the gas per ton of coke produced has steadily increased.

One of the factors in the increase has been a remarkable reduction in the quantity of gas required for the operation of coking itself, with a corresponding increase in the surplus available for sale. (See Table 81 and fig. 61.) In 1915 the surplus constituted but 39.5 per cent of the total quantity produced. In 1922 the surplus had risen to 52.2 per cent. This gratifying showing has been brought about by a reduction in the percentage of gas wasted, but principally by improvements in the technique of operation and in oven design. Again, at

some plants a favorable market for gas has made it possible to heat the oven with producer gas, thus freeing a larger surplus of the higher-quality coke-oven gas for sale.

TABLE 79.—*Disposition of gas from by-product coke ovens, 1915–1922, in per cent.*

Year.	Wasted.	Burned in coking process.	Surplus sold or used (not for ovens).	Year.	Wasted.	Burned in coking process.	Surplus sold or used (not for ovens).
1915	3.2	57.3	39.5	1919	2.6	51.0	46.4
1916	4.0	58.4	37.6	1920	2.2	49.5	48.3
1917	5.4	55.7	38.9	1921	2.9	47.4	49.7
1918	4.1	54.8	41.1	1922	1.9	45.9	52.2

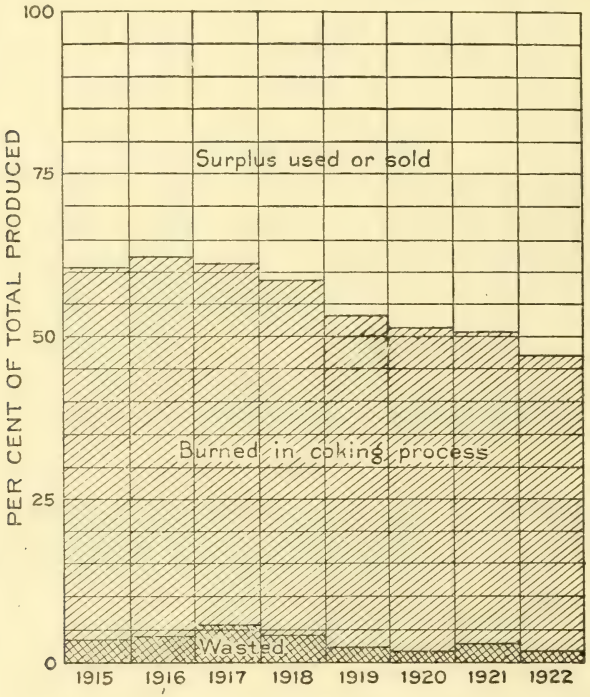

FIGURE 61.—Disposition of gas produced at by-product ovens, 1915–1922.

A factor of greater influence in the increasing value of the surplus gas has been the better prices obtained in the last three years. Figure 62 and Table 80 show the trend of gas prices. Like other rates subject to public regulation, the charges for both manufactured and natural gas when distributed by public-utility companies have lagged behind general commodity prices. Thus the curves of household prices in Figure 62 show no increase in 1916 and 1917 and only a very slight increase in 1918, although general prices and wages were rising rapidly during that period. In fact the most notable advance in prices of gas for household use did not occur until 1921, at a time when general commodity prices had begun to fall. The average

receipts from sales of natural gas at the point of consumption and of coal, oil, and water gas as distributed by public-utility companies have followed in a general way the change in regulated prices of household gas. The average value of the coke-oven gas, shown by the bottom curve of the diagram, also reflects the changes in the price of competing gaseous fuel. The fact that it shows a decrease from 1915 to 1919 means not that prices of coke-oven gas were falling but rather that the average was being depressed by the rapid growth of new plants associated with the steel industry of western Pennsylvania and Ohio, where because of the presence of natural gas the average value per unit was necessarily low. (See discussion of third period in the construction of by-product coke ovens, p. 704.)

Most of the ovens of this type had been completed by 1919, and beginning with 1920 the curve merely shows the trend of price increase. From an average of 8.6 cents in 1919 the price of surplus gas rose to an average of 14 cents in 1920 and showed still further increase in 1921. It should be noted that the value placed upon coke-oven gas by some operators is arbitrary. To the gas used under boilers about a coke plant or turned over to an affiliated steel works as a fuel for open-hearth furnaces the operator is requested to assign a "cost-keeping" value. Such a value may be distinctly less than the price an outside consumer would be willing to pay for the same gas—a fact which accounts in part for the very wide margin between the average value of coke-oven gas and the average value of coal, oil, and water gas. But it must be remembered that though coke-oven gas is practically the equivalent of other manufactured gas in heating value, the value of other manufactured gas as here given includes the services of the distributing companies in piping it to the consumer, whereas the value of the coke-oven gas is commonly the value of the gas turned over to the distributing companies or to some large consumer in a manner that involves no great outlay for distribution.

The curve for coke-oven gas does not, however, seem disproportionate to that for the value of all natural gas at the point of consumption, when it is recalled that natural gas has a heating value 60 to 100 per cent greater than that of coke-oven gas. The heating value of coke-oven gas before removal of the benzols ranges from 530 to 630 British thermal units per cubic foot. The same gas after removing the benzol would range from 500 to 600 British thermal units. Ordinary coal gas ranges from 550 to 600 British thermal units. Blue water gas has a value of about 300 British thermal units, and carbureted water gas 550 to 900 British thermal units. Natural gas, showing wide variation, runs about 1,000 British thermal units per cubic foot. Producer gas, sometimes used in place of coke-oven gas to heat the by-product oven, has a value of 120 to 150 British thermal units.

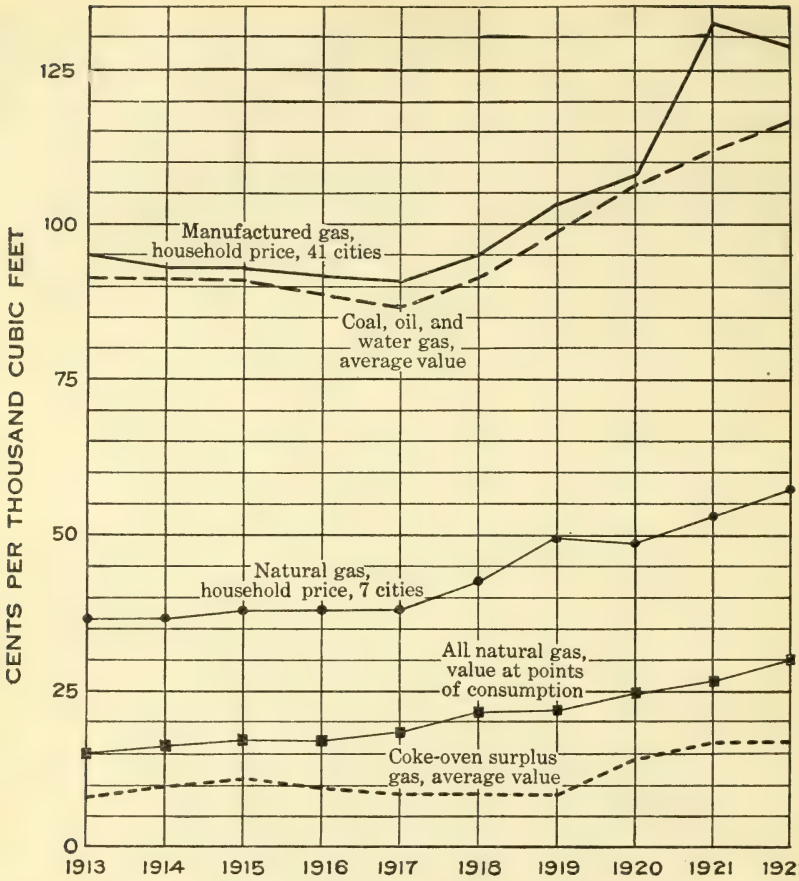

FIGURE 62.—Trend of prices of gas, 1913–1922.

Household prices from Bureau of Labor Statistics, Department of Labor. Average values of all gas sold from reports of producers to United States Geological Survey.

TABLE 80.—*Trend in prices of gas per M cubic feet, 1913–1922.*

Year.	Average price to householders.[a]		Average value of all gas sold.[b]		
	Manufactured gas (41 cities).	Natural gas (7 cities).	Natural gas.[c]	Coal, oil, and water gas.	Coke-oven surplus gas.[d]
1913	$0.95	$0.37	$0.151	[e] $0.91	$0.088
1914	.93	.37	.159	(f)	.098
1915	.93	.38	.161	.91	.102
1916	.92	.38	.160	(f)	.098
1917	.91	.38	.179	.87	.087
1918	.95	.43	.213	.91	.087
1919	1.03	.49	.216	(f)	.086
1920	1.08	.49	.246	1.06	.140
1921	1.31	.53	.264	(f)	.168
1922	1.28	.57	.291	1.16	.167

[a] Computed from statistics of prices published by Bureau of Labor Statistics. See Monthly Labor Review, April, 1924. Average of prices in effect on or near April 15. Further additions to price in form of monthly service charge were made in this period.
[b] As reported by operators to the Geological Survey.
[c] Average value of all natural gas at point of consumption.
[d] Includes value of gas used by producer (not for ovens).
[e] Represents 1912.
[f] No report.

Granted a market for its coke, the most important consideration in the choice of a location for a new by-product plant is an outlet for its gas at favorable prices. In forecasting the demand for gas no factor is of greater consequence than the probable change in the production of natural gas. From all the geologic and commercial evidence available it appears that the production of natural gas can not be greatly increased over the average rate of the last few years, if indeed it can be long maintained at that rate. There is a natural tendency to replace natural gas with manufactured gas in regions where the consumption is sufficiently concentrated and where solid or liquid fuels will not do the work more cheaply than gas. The process of supplementing natural with manufactured gas has already gained headway and will undoubtedly continue. Figure 63 and Table 81 show the rates at which the output of natural gas and manufactured gas have been increasing.

In supplementing the supply of natural gas, coke-oven gas has some advantages over the other forms of manufactured gas—coal gas, oil gas, and water gas. In the ten years from 1913 to 1922 the output of natural gas increased 31 per cent, while the production of all manufactured gas more than doubled. It will be seen from the diagram that the greater part of the increase in manufactured gas was contributed by the coke ovens. The supply of coal, oil, and water gas increased by 55 per cent, but that of surplus coke-oven gas was nearly four times as great in 1922 as in 1913.

An interesting example of the possible interplay of natural gas and coke-oven gas is the practice of an Indiana plant of enriching a lean coke-oven gas with natural gas of 1,100 British thermal units; the mixture has a heating value of 650 British thermal units.

TABLE 81.—*Total production of gas fuel in the United States, 1913–1922.*

[Does not include producer gas, blast-furnace gas, Pintsch gas, or acetylene.]

Year.	Quantity sold (billion cubic feet).				Rough equivalent in heating value (billion British thermal units).			
	1 Surplus coke-oven gas.	2 Coal, oil, and water gas.	3 Natural gas.	4 Total.	5 Surplus coke-oven gas (1×550).	6 Coal, oil, and water gas (2×575).	7 Natural gas (3×1,000).	8 Total (5+6+7).
Quantities.								
1913	64	[a] 166	582	812	35,200	95,450	582,000	712,650
1914	61	174	592	827	33,550	100,050	592,000	725,600
1915	84	[a] 182	629	895	46,200	104,650	629,000	779,850
1916	110	196	753	1,059	60,500	112,700	753,000	926,200
1917	131	[a] 211	795	1,137	72,050	121,325	795,000	988,750
1918	158	234	721	1,113	86,900	134,550	721,000	942,345
1919	193	[a] 248	746	1,187	106,150	142,600	746,000	994,750
1920	230	262	798	1,290	126,500	150,650	798,000	1,075,150
1921	154	[b] 246	662	1,062	84,700	141,450	662,000	888,150
1922	231	257	763	1,251	127,050	147,775	763,000	1,037,825
Per cent.								
1913	7.9	20.5	71.6	100.0	4.9	13.4	81.7	100.0
1914	7.4	21.0	71.6	100.0	4.6	13.8	81.6	100.0
1915	9.4	20.3	70.3	100.0	5.9	13.4	80.7	100.0
1916	10.4	18.5	71.1	100.0	6.5	12.2	81.3	100.0
1917	11.5	18.6	69.9	100.0	7.3	12.3	80.4	100.0
1918	14.2	21.0	64.8	100.0	9.2	14.3	76.5	100.0
1919	16.3	20.9	62.8	100.0	10.7	14.3	75.0	100.0
1920	17.8	20.3	61.9	100.0	11.8	14.0	74.2	100.0
1921	14.5	23.2	62.3	100.0	9.6	15.9	74.5	100.0
1922	18.5	20.5	61.0	100.0	12.3	14.2	73.5	100.0

[a] Estimated by assuming a uniform rate of increase between successive years reported.
[b] Estimated from census reports, which show slight decrease as compared with 1919, although the census returns include some coke ovens.

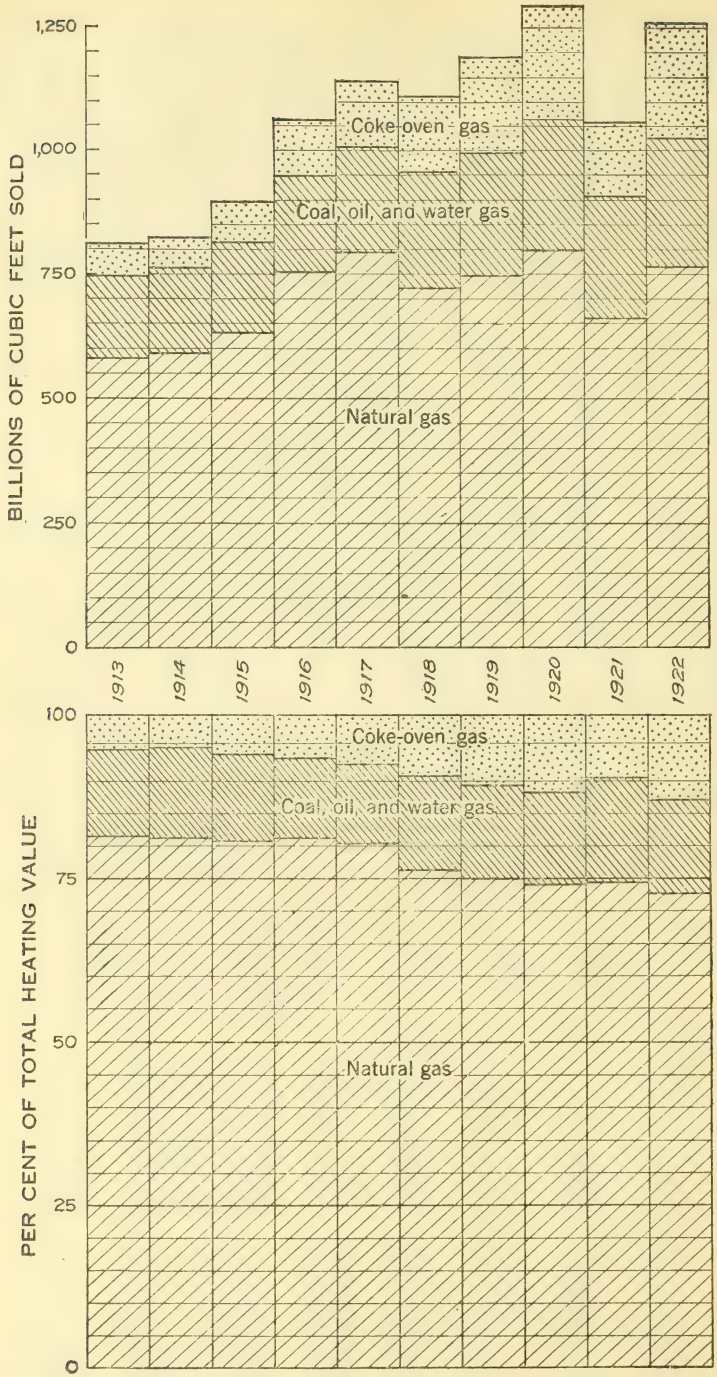

FIGURE 63.—Growth of sales of coke-oven gas, other manufactured gas, and natural gas, and percentage that each formed of the total heating value of all gas sold, 1913–1922.

Figures for coke ovens represent only surplus gas. Heating value of natural gas taken as 1,000 British thermal units per cubic foot, of coke-oven gas 550, and of coal, oil, and water gas combined 575.

Sixty-four plants reported the production of coke-oven gas in 1922. Their combined output was 442,671,114 M cubic feet (Table 82). Of this quantity approximately 203,000,000 M cubic feet was burned in the ovens to produce the coke; 231,000,000 M cubic feet was surplus gas, either sold or used about the plant for some purpose not immediately connected with coking; and 8,000,000 M cubic feet was reported as wasted—that is, it was gas for which no use could be found.

The uses made of the gas in 1922 are shown in Tables 82 to 85. The gas wasted constituted but 1.9 per cent of the total production; 45.9 per cent went to heat the coke ovens, leaving a surplus of 52.2 per cent, an improvement over 1921, when surplus gas represented only 49.7 per cent of the total produced. Relatively small portions were used under boilers in the coke plant—3.9 per cent in 1921 and 4.3 per cent in 1922. That the steel industry affords the principal outlet for coke-oven gas is seen by the fact that one-third of the total production, equivalent to 63 per cent of the surplus gas, was delivered to steel or other affiliated plants. The remainder, amounting to 14.1 per cent of the total production in 1921 and 15.2 per cent in 1922, was sold for other purposes, including domestic cooking and lighting, street lighting, and various industrial uses. The relative proportions used for each of these last-named purposes can not be stated, because the companies do not have the necessary records. In an effort to ascertain the quantities delivered to large industries direct by the by-product operators without the assistance of a public-utility distributing system, the Geological Survey added to its questionnaire in 1922 an inquiry as to "the amount sold for industrial purposes." To this the producers returned replies indicating a total of 10,353,000 M cubic feet, or 2.3 per cent of the entire production in 1922. The quantity distributed through city mains as a part of the local public-utility supply was reported as 56,930,000 M cubic feet, or 12.9 per cent of the production. In 1921, when returns of sales to nonaffiliated industries other than steel were not requested, the 43,826,000 M cubic feet reported as distributed through city mains probably included industrial sales.

TABLE 82.—*Coke-oven gas produced and sold in the United States in 1922, by States.*

State.	Number of plants.	Produced (M cubic feet).	Used in process (M cubic feet).	Sold or used.			Wasted (M cubic feet).
				M cubic feet.	Value.		
					Total.	Average.	
Alabama	7	56,751,416	28,132,352	25,538,957	$1,600,456	$0.063	3,080,107
Colorado	1	5,928,274	2,671,916	3,145,778	[a]	[a]	110,580
Illinois	6	31,982,059	16,225,835	15,588,668	4,492,844	.288	167,556
Indiana	6	61,858,103	30,475,643	30,076,178	4,895,365	.163	1,306,282
Kentucky	1	7,085,680	3,736,776	3,165,066	127,718	.040	183,838
Maryland	1	9,187,573	2,896,540	6,291,033	[a]	[a]	
Massachusetts	1	6,065,888	3,324,274	2,741,614	[a]	[a]	
Michigan	3	17,306,159	7,557,612	9,748,547	3,216,068	.330	
Minnesota	3	6,955,751	3,558,456	3,374,588	1,059,876	.314	22,707
New Jersey	2	12,347,738	1,352,560	10,995,178	[a]	[a]	
New York	5	23,739,254	12,531,120	11,150,782	1,691,306	.152	57,352
Ohio	11	76,591,445	34,251,848	40,817,941	4,794,331	.117	1,521,656
Pennsylvania	9	105,567,898	47,390,995	57,280,898	6,265,001	.109	896,005
Tennessee	1	358,922	179,461	179,461	25,961	.145	
Washington	1	90,019		84,537	59,383	.702	5,482
West Virginia	3	8,544,311	3,295,948	4,674,495	635,501	.136	573,868
Missouri, Rhode Island, and Wisconsin	3	12,310,624	5,657,507	6,529,297	2,723,256	.417	123,820
Undistributed					7,038,254		
	64	442,671,114	203,238,843	231,383,018	38,625,320	.167	8,049,253

[a] Included under "Undistributed."

TABLE 83.—*Disposition of gas from by-product ovens in the United States in 1921 and 1922.*

	Millions of cubic feet.	Percentage of total production.	Value.	
			Total.	Cents per M.
1921.				
Used under boilers	12,123	3.9	$1,120,087	9.2
Used in steel or other related plants	98,352	31.7	10,593,204	10.8
Distributed through city mains (sold), including sales to nonaffiliated industries	43,826	14.1	14,249,961	32.5
Total sold or used (not for ovens)	154,301	49.7	25,963,252	16.8
Used in heating ovens	147,038	47.4		
Wasted	8,850	2.9		
Total produced	310,189	100.0		
1922.				
Used under boilers	19,124	4.3	1,251,325	6.5
Used in steel or other related plants	144,976	32.7	15,942,446	11.0
Distributed through city mains	56,930	12.9	20,326,648	35.7
Sold for industrial purposes	10,353	2.3	1,104,901	10.7
Total sold or used (not for ovens)	231,383	52.2	38,625,320	16.7
Used in heating ovens	203,239	45.9		
Wasted	8,049	1.9		
Total produced	442,671	100.0		

Tables 84 and 85 show the details by States of the use made of the surplus gas in 1921 and 1922. The market for the gas of course varies with the industries of the locality and with the density of population. In the centers of steel production of Pennsylvania and Ohio, in the Buffalo, Chicago, and Birmingham districts, and at the plant at Pueblo, Colo., the great bulk of the surplus gas was delivered to affiliated steel works or used under boilers in the by-product plants themselves. At other plants, either owned by public utilities or supplying them with gas under contract, the greater part of the output was distributed through city mains. This was the condition in Maryland, Massachusetts, Michigan, Minnesota, New Jersey, Washington, Missouri, Rhode Island, and Wisconsin, in that part of Indiana outside of the Chicago district, and even at a number of plants in the Chicago district itself. Among the large producing States the highest percentage distributed through city mains was reported from New Jersey, where 89 per cent of the entire output was delivered for public-utility supply.

TABLE 84.—*Use of by-product gas in the United States in 1922, by States.*

State.	Used under boilers.			Used in steel or other affiliated plants.			Distributed through city mains.			Sold for industrial purposes.		
	M cubic feet.	Value.		M cubic feet.	Value.		M cubic feet.	Value.		M cubic feet.	Value.	
		Total.	Average.		Total.	Average.		Total.	Average.		Total.	Average.
Alabama	8,130,841	$425,258	$0.052	13,935,292	$798,597	$0.057	1,184,175	$178,060	$0.150	2,288,649	$198,541	$0.087
Colorado				3,145,778	(a)	(a)						
Illinois	215,257	22,992	.107	3,857,323	462,879	.120	10,828,629	3,871,303	.357	687,459	135,670	.197
Indiana	816,904	93,327	.114	24,991,497	2,842,949	.114	3,731,827	1,775,975	.476	535,950	183,114	.342
Kentucky	2,509,475	100,379	.040							655,591	27,339	.042
Maryland				1,724,249	(a)	(a)	4,428,076	(a)	(a)	138,708	19,234	.138
Massachusetts							2,741,614	(a)	(a)			
Michigan	120	6	.050	2,919,607	888,009	.304	6,812,725	2,327,248	.342	16,095	805	.050
Minnesota	278,534	16,355	.059	287,938	40,311	.140	2,808,116	1,003,210	.357			
New Jersey							10,995,178	(a)	(a)			
New York	2,879,929	231,732	.080	6,177,733	408,782	.066	2,092,952	1,050,705	.502	168	87	.518
Ohio	1,996,547	177,409	.089	32,541,577	4,044,058	.124	793,156	75,364	.095	5,486,661	497,500	.091
Pennsylvania	1,899,201	170,825	.090	53,104,940	5,756,618	.108	1,733,117	294,947	.170	543,640	42,611	.078
Tennessee	109,970	3,849	.035				69,491	22,112	.318			
Washington	2,637	2,264	.859				81,900	57,119	.697			
West Virginia	284,399	6,929	.024	2,290,096	166,572	.073	2,100,000	462,000	.220			
Missouri, Rhode Island, and Wisconsin							6,529,297	2,723,256	.417			
Undistributed					533,671	.110		6,485,349	.357			
	19,123,814	1,251,325	.065	144,976,030	15,942,446	.110	56,930,253	20,326,648	.357	10,352,921	1,104,901	.107

(a) Included under "Undistributed."

TABLE 85.—*Yield and disposal of gas and number of plants supplying gas for certain uses in 1922, by States.*

State.	Yield of gas (M cubic feet per ton of coal coked).	Disposal (per cent of total).						Number of plants.	
		In coke plants.		To steel or other affiliated plants.	For distribution through city mains.	For industrial purposes.	Wasted.	Supplying gas for city distribution.	Supplying gas to steel or other affiliated plants.
		For use in heating coke ovens.	For use under boilers.						
Alabama	11.1	49.6	14.3	24.6	2.1	4.0	5.4	2	4
Colorado	11.2	45.1		53.1			1.8		1
Illinois	11.1	50.7	.7	12.1	33.9	2.1	.5	5	1
Indiana	11.2	49.3	1.3	40.4	6.0	.9	2.1	5	3
Kentucky	11.3	52.7	35.4			9.3	2.6		
Maryland	11.5	31.5		18.8	48.2	1.5		1	1
Massachusetts	10.0	54.8			45.2			1	
Michigan	11.0	43.7		16.9	39.4			3	1
Minnesota	10.1	51.2	4.0	4.1	40.4		.3	2	1
New Jersey	11.4	11.0			89.0			2	
New York	10.7	52.8	12.1	26.0	8.8		.3	2	2
Ohio	10.8	44.7	2.6	42.5	1.0	7.2	2.0	3	7
Pennsylvania	10.2	44.9	1.8	50.3	1.6	.5	.9	2	8
Tennessee	9.7	50.0	30.6		19.4			1	
Washington	9.6		2.9		90.9		6.2	1	
West Virginia	11.3	38.6	3.3	26.8	24.6		6.7	1	1
Missouri, Rhode Island, and Wisconsin	10.9	45.9			53.0		1.1	3	
	10.8	45.9	4.3	32.7	12.9	2.3	1.9	34	30

The percentage of gas used in heating the ovens is determined largely by the oven design and to a less extent by the skill of the operator and the percentage of volatile matter in the coal carbonized. The average percentage for each State is shown in the second column of Table 85, and Table 86 distributes the plants by efficiency groups. When operating with high-volatile coal of good quality, the most modern types of ovens require only 35 to 40 per cent of the gas. The increasing prices of gas are directing the attention of operators to the use of cheaper gas from other sources to heat the ovens. Blue water gas or producer gas have been used to great advantage for this purpose by plants supplying gas for city distribution. Some of the modern types of ovens are designed to permit the ready substitution of producer gas or blue water gas for the richer oven gas whenever the seasonal demand for gas in the city supply makes the change desirable. This type of design is likely to meet with favor in new plants built near cities that offer a possible market for gas. Producer gas is so lean that it must be preheated before it can be substituted for the oven gas. Blast-furnace gas also may be used to heat the ovens, but so far as known to the Geological Survey it was not so employed in 1922.

That the substitution of lean gas for the richer coke-oven gas is a commercial reality may be seen by the fact that only 11 per cent of the gas produced at coke ovens in New Jersey in 1922 was required to heat the ovens, leaving a surplus of 89 per cent.

The blue water gas may be made from the plant's own coke and the producer gas from its breeze, thus affording an outlet for a by-product that often has to be sacrificed at low prices. Not the least of the advantages of the feasible operation under this plan is the

means that it affords of adjusting the relative proportions of coke and gas offered to the market. A surplus of coke relative to gas can be reduced by using more coke to make lean gas, thus freeing the entire output of oven gas for sale. A surplus of gas relative to coke can be reduced by heating the ovens with oven gas itself, thus freeing the entire output of coke and breeze for sale.

TABLE 86.—*Gas used in heating ovens in 1921 and 1922.*

	1921	1922
Total quantity of gas reported as used in heating ovens.....M cubic feet	147,037,412	203,238,843
Percentage of total production used:		
At plant reporting minimum percentage	[a]14.5	[a]13.6
At plant reporting maximum percentage	93.6	97.7
At average plant [b]	53.7	49.7
Average for all gas produced [c]	47.4	45.9
Total number of plants reporting	63	59
Number of plants reporting—		
Less than 20 per cent used	[a]1	[a]1
20–29.9 per cent	[d]2	
30–39.9 per cent	8	8
40–44.9 per cent	13	14
45–49.9 per cent	11	15
50–59.9 per cent	9	10
60–69.9 per cent	9	7
70–79.9 per cent	2	2
80–89.9 per cent	2	1
90 per cent or more	6	1

[a] This plant used also some other gas for heating ovens.
[b] Sum of averages for all plants divided by number of plants.
[c] Total gas used in heating all ovens divided by total gas produced.
[d] Probably does not represent the total used.

Within the range of the temperatures employed in present by-product coking practice, the yield of gas per ton of coal charged is largely affected by the coal used and depends to a lesser extent upon the method of oven operation and the design of the oven itself and still less upon the skill of the operator. The statistics of the yield of gas per ton of coal carbonized are therefore not to be used as a measure of plant-operating efficiency. They do, however, represent the results obtained under the actual conditions of operation and with the coals available in different localities. The average yield in each State is shown in the first column of Table 85, and the number of plants attaining each of several specified yields in Table 87. The averages per plant range from less than 8 M cubic feet per ton of coal carbonized to 12 M cubic feet or more. The highest average reported by any one plant was 12.8 M cubic feet, and the lowest 7.5 M cubic feet.

TABLE 87.—*Yield of gas per ton of coal coked reported by coke plants in 1921 and 1922.*

	1921	1922
Total production of gas.....M cubic feet..	310,188,713	442,671,114
Yield of gas per ton of coal coked:		
At plant reporting minimum average yield.....do....	5.0	7.5
At plant reporting maximum average yield.....do....	14.1	12.8
At average plant [a].....do....	10.5	10.7
Average for all coal coked [b].....do....	10.8	10.8
Total number of plants reporting recovery of gas	67	63
Number of plants reporting yields of—		
Less than 8 M cubic feet per ton of coal coked	2	1
8–8.99 M cubic feet	3	2
9–9.99 M cubic feet	12	10
10–10.49 M cubic feet	11	18
10.5–10.99 M cubic feet	21	6
11–11.99 M cubic feet	10	19
12 M cubic feet or more	8	7

[a] Sum of averages for all plants divided by number of plants.
[b] Total production of gas divided by number of tons of coal coked.

In the discussion of the trend in the price of gas reference was made to the arbitrary nature of estimates by producers of the value of gas used in the coke plant for purposes other than heating ovens and of gas delivered to an affiliated steel works or other establishment. The values given in the accompanying tables are those reported by the operators and have not been readjusted by the Survey to accord with what might appear to be the commercial value of the gas in the same localities. The price credited to the coke department for gas supplied to an affiliated open-hearth plant is frequently determined by the cost of an equivalent quantity of the cheapest available substitute fuel. The credit given on gas used in this way in 1922 averaged only 11 cents per M cubic feet, a figure surely below the ruling price of such fuel in the districts concerned. As shown in Table 88, in which plants are grouped according to the average receipts for each M cubic feet sold, there was one plant that set a value of less than 5 cents per M on gas delivered to steel works and one plant that received 30 cents per M. Gas used under boilers in the coke plant itself was credited at an average of 6½ cents per M, and six plants valued it at less than 5 cents. Gas delivered for distribution through city mains was naturally sold at a much higher price. The average receipts were 35.7 cents per M, yet even here there was the widest variation, due to the varying financial relations between the coke ovens and the distributing companies. In two plants where the battery of coke ovens is operated as part of a public-utility system the value is placed at over $1 per M. Such a price implies a system of bookkeeping under which the coke plant is charged with its part of the cost of distribution through the mains of the city. At other such plants gas was priced at less than 10 cents, and the price most commonly reported was between 10 and 20 cents. These low average receipts represent transfers to a distributing company where the overhead and operating costs of piping the gas through the city and delivering it to the consumer are not borne by the coke plant.

TABLE 88.—*Average receipts per M cubic feet of gas sold for certain uses reported by coke plants in 1921 and 1922.*

	1921			1922		
	City gas.	Boiler use.	Steel-plant use.	City gas.	Boiler use.	Steel-plant use.
Total sales of gas.....M cubic feet..	43,826,172	12,122,777	98,352,049	70,990,253	19,123,814	144,976,090
Average receipts per M cubic feet of gas sold:						
At plant reporting minimum average receipts	$0.08	$0.004	$0.04	$0.09	$0.003	$0.04
At plant reporting maximum average receipts	1.21	.82	.40	1.51	.86	.30
At average plant [a]	.343	.127	.112	.343	.100	.106
Average receipts for all gas sold or used [b]	.325	.092	.108	.357	.065	.110
Total number of plants reporting sales	38	31	40	34	36	30
Number of plants reporting—						
Less than 5 cents per M cubic feet sold		5	2		6	1
5–9 cents	4	12	11	2	12	11
10–19 cents	15	11	24	10	17	17
20–29 cents	5		2	6		
30–39 cents	1			4		1
40–49 cents	3	1	1	7		
50–59 cents	3			2		
60–69 cents	1	1				
70–79 cents	4	1		1	1	
$1 or more	2			2		

[a] Sum of averages for all plants divided by number of plants.
[b] Total value of sales divided by number of M cubic feet sold.

NAPHTHALENE.

About one-third of the domestic output of refined naphthalene is said to go normally to dealers in the form of flake and balls to be used for protection against moths. Naphthalene is one of the important crude materials for the manufacture of coal-tar dyes, and in recent years the domestic supplies have frequently been insufficient, so that imports have been needed.

Naphthalene is present in the hot gas as it leaves the coke oven. It condenses out and is recovered in the light oils from which benzol and toluol are derived and in the tar. Its recovery by coke-oven operators is largely incidental to the washing of the gas and the refining of light oil. If the market is favorable it may be sold; if not, it may be put into the tar in the coke plant.

The amount of naphthalene produced for sale at coke plants thus depends upon the price. High prices of benzol and toluol, inducing careful refining of the light oil into its several constituents, will produce large amounts of naphthalene; or if the price of naphthalene rises, it will be recovered for its own value. The maximum production by coke plants was made in 1918, when a total of 15,890,000 pounds was recovered and sold.

Naphthalene is also a by-product of the manufacture of coal gas and is present in coal-gas tar. Very few gas companies, however, prepare it for sale. The maximum sales by gas companies in any recent year amounted to 1,760,000 pounds.

The largest contribution to the domestic production is made by the refiners of coal-gas tar and coke-oven tar, whose output, as reported by the Tariff Commission, has ranged from 12 to 40 million

pounds a year and far exceeds the combined sales from coke plants and gas works.

The total supplies available in the United States market, including imports, are given in Table 89.

TABLE 89.—*Total commercial production of naphthalene from all sources in the United States, 1918–1922.*

[Total sales are shown for coke plants and gas works to avoid double counting in production of crude and refined.]

	By-product coke ovens; sales of crude and refined.	City gas works; sales of crude and refined.	Tar distilleries and all other establishments.	Total commercial production.
Quantity (pounds):				
1918	15,890,447	896,080	40,138,092	56,924,619
1919	6,702,040	[a]	12,612,203	20,114,243
1920	14,448,762	1,760,293	26,393,411	42,602,466
1921	1,983,523	[a]	16,949,464	19,432,987
1922	4,887,935	[a]	19,323,393	25,411,328
Value:				
1918	$650,229	$14,282	$1,281,440	$1,945,951
1919	191,364	[a]	327,201	542,565
1920	487,974	63,449	791,403	1,342,826
1921	59,335	[a]	380,167	462,502
1922	131,252	[a]	352,957	536,209

	Imports of crude [b] (free).	Imports of refined [b] (dutiable).	Total imports.[b]	Total produced and imported.	Average spot price of flake in New York (cents per pound).
Quantity (pounds):					
1918	3,902,731	2,795	3,905,526	60,830,145	----------
1919	3,239,256	7,650	3,246,906	23,361,149	----------
1920	15,012,096	3,697,562	18,709,658	61,312,124	----------
1921	4,495,806	441,685	4,937,491	24,370,478	----------
1922	3,144,332	75,680	3,220,012	28,631,340	----------
Value:					
1918	$130,098	$171	$130,269	$2,076,220	9.95
1919	92,265	384	92,649	635,214	7.63
1920	530,219	416,172	946,391	2,289,217	12.68
1921	135,943	31,458	167,401	629,903	7.23
1922	54,029	7,684	61,713	597,922	6.15

[a] Data lacking or incomplete. Estimate included in total.
[b] Imports entered for consumption as reported by Tariff Commission.

Table 89 and Figure 64 reveal a surprising variation in the production from year to year, depending on the demand and the price. In 1918 the production was large, partly because complete refining of light oil for benzol and toluol led to the accumulation of greater supplies of naphthalene and partly because the price was high, the average spot quotation for flake being 10 cents a pound, against 2.3 cents in 1913. The total output of naphthalene from all sources in 1918 was 56,900,000 pounds.

In 1919 prices of both naphthalene and benzol products declined and the production of naphthalene dropped accordingly to 20,114,000 pounds, of which 6,702,000 pounds was contributed by coke plants. In thus decreasing their output the producers were actuated by the belief that large accumulations of stock, before the signing of the armistice, constituted an oversupply. When export restrictions were removed there was an unexpected increase in the export trade in

dyes, and the consumption of naphthalene increased. Stocks were soon exhausted, and in late 1919 and in 1920 there was a shortage which brought about a sharp increase in price (fig. 58). The result was a very large increase in production in 1920. Sales by coke-oven plants rose to 14,449,000 pounds, and those from gas works increased in proportion. Recoveries by tar refiners not associated with the coke ovens or gas works more than doubled, rising from 12,612,000 pounds in 1919 to 26,393,000 pounds in 1920.

In 1921 and 1922, however, the price declined, as shown both by the curve of spot price of flake naphthalene in the New York market (fig. 58) and by the average receipts from sales reported by the coke producers, which decreased from 2.7 cents a pound for crude naphthalene in 1920 to 2.5 cents in 1921 and to still lower levels in 1922 (Table 89). Production and sales of naphthalene were correspondingly curtailed, and the total quantity sold by coke-oven operators in 1922 was only 4,888,000 pounds, for which they received $131,252.

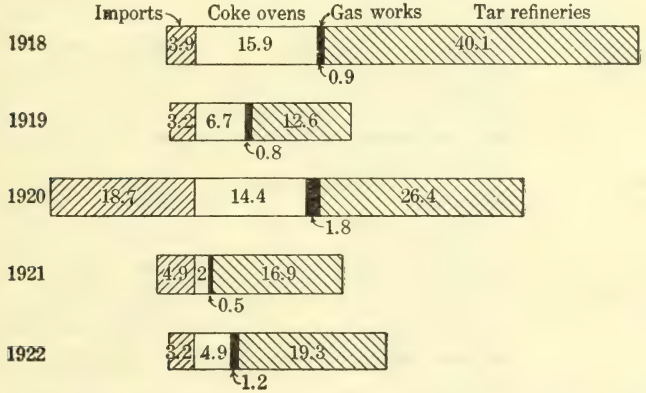

FIGURE 64.—Sources of the supply of naphthalene available in the United States, 1918–1922. Figures in the bars represent millions of pounds.

Though naphthalene brings a higher price per pound than ammonia, for example, the quantities sold are relatively small, and the credits it affords per ton of coke have never exceeded 2.5 cents. Table 90 shows the receipts from the sales made in the last seven years.

TABLE 90.—*Naphthalene sold by by-product coke operators, 1916–1922.*

Year.	Quantity (pounds).			Value.	Average receipts per pound (cents).		Receipts per ton of coke (cents).
	Crude.	Refined.	Total.		Crude.	Refined.	
1916	(a)	(a)	8,820,405	$289,688	3.4		1.5
1917	(a)	(a)	17,276,044	569,449	3.3		2.5
1918	10,403,758	5,486,689	15,890,447	650,229	2.8	6.6	2.5
1919	4,038,455	2,663,585	6,702,040	191,364	2.0	4.1	.8
1920	11,507,703	2,941,059	14,448,762	487,974	2.7	6.1	1.6
1921	1,652,466	331,057	1,983,523	59,335	2.5	5.6	.3
1922	3,298,851	1,589,084	4,887,935	131,252	1.6	5.0	.5

[a] Not separately reported.

RELATION OF THE BY-PRODUCT COKE INDUSTRY TO THE MANUFACTURE OF GAS BY OTHER METHODS.

Because of the intimate and growing connection between the manufacture of by-product coke and of city gas, intelligent discussion of the one is impossible without constant reference to the other. For convenience in comparison the combined output of gas and by-products from coke ovens and coal-gas, water-gas, and oil-gas plants, is given in Table 91.

TABLE 91.—*Summary of output of gas and by-products from manufactured-gas plants and coke ovens in the United States, 1920 and 1922.*

Product and source.	1920			1922		
	Production.	Sales.		Production.	Sales.	
		Quantity.	Value.		Quantity.	Value.
Gas:	*M cu. ft.*	*M cu. ft.*		*M cu. ft.*	*M cu. ft.*	
Coal-gas plants	47,378,501	42,948,127	$49,933,179	46,148,696	42,151,110	$52,427,999
Water-gas plants	220,078,821	200,490,272	210,043,126	210,252,585	193,543,286	222,923,518
Oil-gas plants	22,269,815	19,041,777	18,853,818	24,763,793	21,736,446	23,140,773
Coke ovens	476,485,744	230,415,919	32,234,318	442,671,114	231,383,018	38,625,320
	766,212,881	492,896,095	311,064,441	723,836,188	488,813,860	337,117,610
Coke:	*Net tons.*	*Net tons.*		*Net tons.*	*Net tons.*	
Coal-gas plants	3,137,332	1,378,537	11,638,525	2,877,787	1,387,658	12,032,244
Coke ovens	30,833,951	[a]	[a]	28,550,545	[a]	[a]
	33,971,283	[a]	[a]	31,428,332	[a]	[a]
Tar:	*Gallons.*	*Gallons.*		*Gallons.*	*Gallons.*	
Coal-gas plants	51,264,956	46,604,133	2,010,186	48,082,228	41,266,074	1,955,950
Water-gas plants	114,410,107	58,907,980	2,100,838	97,232,985	47,308,129	1,877,563
Oil-gas plants	1,663,800	330,750	8,550	7,322,043	30,360	1,927
Coke ovens	360,664,124	174,363,696	6,378,040	327,779,734	162,204,417	6,419,743
	528,002,987	280,206,559	10,497,614	480,416,990	250,808,980	10,255,183
Ammonia (sulphate equivalent)	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	
Coal-gas plants	57,970,606	55,350,961	1,252,726	53,058,180	50,442,270	1,135,645
Coke ovens	938,925,522	874,321,063	35,695,433	898,465,061	909,618,826	22,389,812
	996,896,128	929,672,024	36,948,159	951,523,241	960,061,096	23,525,457
Crude light oil and derived products:	*Gallons.*	*Gallons.*		*Gallons.*	*Gallons.*	
Coal-gas plants	[b]	[b]	[b]			
Water-gas plants	2,905,700	3,142,425	271,168	3,920,037	404,980	98,789
Oil-gas plants						
Coke ovens	109,709,915	81,227,914	18,860,682	101,437,555	77,308,900	15,667,934
	[b]	[b]	[b]	105,357,592	77,713,880	15,766,723
Drip or holder oils:	*Gallons.*	*Gallons.*		*Gallons.*	*Gallons.*	
Coal-gas plants	146,427	118,307	9,781	97,815	84,555	4,726
Water-gas plants	4,266,889	3,956,699	227,673	3,438,798	3,311,022	182,686
Oil-gas plants	14,090	14,090	4,245	5,000		
	4,427,406	4,089,096	241,699	3,541,613	3,395,577	187,412
Naphthalene (crude and refined):	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	
Coal-gas plants	[b]	1,483,993	58,037	[c]	[c]	[c]
Water-gas plants	134,433	275,900	5,400			
Oil-gas plants	400	400	12			
Coke ovens	14,168,089	14,448,762	487,974	7,918,714	4,887,935	131,252
	[b]	16,209,055	551,423	8,768,714	6,087,935	183,252

[a] Sales of coke from by-product ovens not comparable, as 90 per cent of the production is used by the operator. The total value of the coke produced, including estimates for coke consumed in associated iron furnaces but not sold, was for 1920, $313,028,732, and for 1922, $188,276,767.

[b] Because of double counting between crude and refined, the total production of gas plants can not be shown.

[c] Data incomplete. Estimate included in total.

TABLE 91.—*Summary of output of gas and by-products from manufactured-gas plants and coke ovens in the United States, 1920 and 1922*—Continued.

Product and source.	1920			1922		
	Production.	Sales.		Production.	Sales.	
		Quantity.	Value.		Quantity.	Value.
Retort carbon:	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	
Coal-gas plants	1,025,466	783,985	$5,739	609,347	223,195	$2,199
Coke ovens	44,000	44,000	340			
	1,069,466	827,985	6,079	609,347	223,195	2,199
Lampblack: Oil-gas plants	*Pounds.* 203,281,411	*Pounds.* [d]71,292,159	295,149	*Pounds.* 356,260,722	*Pounds.* [d] 5,892,145	4,897
Miscellaneous by-products:						
Coal-gas and water-gas plants			428,324			175,575
Coke ovens			[e] 1,284,981			[e] 1,737,906
			1,713,305			1,913,481
Value of products of the coal-gas, water-gas, and oil-gas industry:						
Gas sold			278,830,123			298,492,290
By-products sold			19,122,050			17,524,201
			297,952,173			316,016,491
Value of products of the by-product coke industry:						
Coke			313,028,732			188,276,767
Gas sold			32,234,318			38,624,515
Other by-products sold			62,707,450			46,346,647
			407,970,500			273,247,929
Total value of products of manufactured-gas industries sold, excluding by-product coke			392,893,941			400,987,653

[d] In addition, lampblack used for briquets, 74,474,000 pounds in 1920 and 205,865,000 pounds in 1922.
[e] Includes value of coke breeze, which amounted to $1,249,004 in 1920 and $1,583,399 in 1922.

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DEPARTMENT OF THE INTERIOR
Hubert Work, Secretary

UNITED STATES GEOLOGICAL SURVEY
George Otis Smith, Director

COKE PRODUCED IN THE UNITED STATES, 1880-1922

(Net tons.)

Year.	Alabama.	Colorado.	Georgia.	Illinois.	Indiana.	Kansas.	Kentucky.	Maryland.	Massachusetts.	Michigan.	Minnesota.	Missouri.	Montana.	New Jersey.	New Mexico.	New York.	Ohio.	Oklahoma (Indian Territory).	Pennsylvania.	Rhode Island.	Tennessee.	Texas.	Utah.	Virginia.	Washington.	West Virginia.	Wisconsin.	Wyoming.	Other States.	Total.	Year.
1880	60,781	25,568	38,041	12,700	.....	3,070	4,250	.....	.....	.....	.....	.....	.....	.....	.....	.....	100,596	1,546	2,821,384	.....	130,609	.....	1,000	.....	.....	138,755	.....	.....	.....	3,338,300	1880
1881	109,033	48,587	41,376	14,800	.....	5,670	4,370	.....	.....	.....	.....	.....	.....	.....	.....	.....	119,469	1,768	3,437,708	.....	143,853	.....	.....	.....	.....	187,126	.....	.....	.....	4,113,760	1881
1882	152,940	102,105	46,602	11,400	.....	6,080	4,070	.....	.....	.....	.....	.....	.....	.....	1,000	.....	103,722	2,025	3,945,034	.....	187,695	.....	250	.....	.....	230,398	.....	.....	.....	4,793,321	1882
1883	217,531	133,997	67,012	13,400	.....	8,430	5,025	.....	.....	.....	.....	.....	.....	.....	3,905	.....	87,834	2,573	4,438,464	.....	203,691	.....	.....	25,340	.....	257,519	.....	.....	.....	5,464,721	1883
1884	244,009	115,719	79,268	13,095	.....	7,190	2,223	.....	.....	.....	.....	.....	75	.....	18,282	.....	62,709	1,912	3,822,128	.....	219,723	.....	.....	63,600	400	223,472	.....	.....	.....	4,873,805	1884
1885	301,180	131,960	70,669	10,350	.....	8,050	2,704	.....	.....	.....	.....	.....	175	.....	17,940	.....	39,416	3,584	3,991,805	.....	218,842	.....	.....	49,139	311	260,571	.....	.....	.....	5,106,696	1885
1886	375,054	142,797	82,680	8,103	6,124	12,493	4,528	.....	.....	.....	.....	.....	.....	.....	10,236	.....	34,932	6,351	5,406,597	.....	368,139	.....	.....	122,352	825	264,158	.....	.....	.....	6,845,369	1886
1887	325,020	170,698	79,241	9,198	17,658	14,950	14,565	.....	.....	.....	.....	2,970	7,200	.....	13,710	.....	93,004	10,060	5,832,849	.....	396,979	.....	.....	166,947	14,625	442,031	.....	.....	.....	7,611,705	1887
1888	508,511	179,682	83,721	7,410	11,956	14,831	23,150	.....	.....	.....	.....	2,600	12,000	.....	8,540	.....	67,194	7,502	6,545,779	.....	385,693	.....	.....	149,199	.....	531,762	500	.....	.....	8,540,030	1888
1889	1,030,510	187,638	94,727	11,583	8,301	13,910	13,021	.....	.....	.....	.....	5,275	14,043	.....	3,460	.....	75,124	6,639	7,659,055	.....	359,710	.....	761	146,528	3,841	607,880	16,016	.....	.....	10,258,022	1889
1890	1,072,942	245,756	102,233	5,000	6,013	12,311	12,343	.....	.....	.....	.....	6,136	14,427	.....	2,050	.....	74,633	6,639	8,560,245	.....	348,728	.....	8,528	165,847	5,837	833,377	24,976	.....	.....	11,508,021	1890
1891	1,282,496	277,074	103,057	5,200	3,798	14,174	33,777	.....	.....	.....	.....	6,872	29,009	.....	2,300	.....	38,718	9,464	6,954,846	.....	364,318	.....	7,949	167,516	6,000	1,009,051	34,387	2,682	.....	10,352,688	1891
1892	1,501,571	[a] 373,229	81,807	3,170	3,207	9,132	36,123	.....	.....	.....	.....	7,299	34,557	.....	.....	.....	51,818	3,569	8,327,612	.....	354,096	.....	(a)	147,912	7,177	1,034,750	33,800	.....	.....	12,010,829	1892
1893	1,168,085	[a] 362,986	90,726	2,200	5,724	8,565	48,619	.....	.....	.....	.....	5,905	29,945	.....	5,803	12,850	22,436	7,135	6,229,051	.....	265,777	.....	(a)	125,092	6,731	1,062,076	14,958	2,916	.....	9,477,580	1893
1894	923,817	[a] 317,196	93,029	2,200	6,551	8,439	29,748	.....	.....	.....	.....	2,250	17,388	.....	6,529	16,500	32,640	3,051	6,063,777	.....	292,646	.....	(a)	180,091	5,245	1,193,933	4,250	4,352	.....	9,203,632	1894
1895	1,444,339	[a] 340,357	60,212	2,250	4,804	5,287	25,460	.....	.....	.....	.....	2,028	25,337	.....	14,663	18,521	29,050	5,175	9,404,215	.....	396,790	286	(a)	244,738	15,129	1,285,206	4,972	4,895	.....	13,333,714	1895
1896	1,479,437	[a] 363,760	53,673	2,600	4,353	4,785	27,107	.....	.....	.....	.....	2,500	60,078	.....	24,228	[b]	80,868	21,021	[c] 7,356,502	.....	339,202	.....	(a)	268,081	25,949	1,649,755	5,332	19,542	.....	11,788,773	1896
1897	1,443,017	[a] 342,653	33,000	1,549	2,904	6,181	32,117	.....	.....	.....	.....	2,593	67,849	.....	1,438	[b]	95,087	30,364	[c] 8,966,924	.....	368,769	394	(a)	354,067	26,189	1,472,666	17,216	24,007	.....	13,288,984	1897
1898	1,663,020	[a] 474,808	49,529	2,325	1,825	4,180	22,242	.....	.....	.....	.....	740	52,009	.....	6,980	[b]	85,535	34,110	[c] 10,715,302	.....	394,545	.....	(a)	531,161	30,197	1,925,071	35,280	18,350	.....	16,047,209	1898
1899	1,787,809	[a] 530,424	50,907	[d] 2,370	(d)	14,476	81,095	.....	(b)	.....	.....	2,860	56,376	.....	44,134	[b]	83,878	24,339	[c] 13,577,870	.....	435,308	.....	(a)	618,707	30,372	2,278,577	33,437	15,630	.....	19,668,569	1899
1900	2,110,837	[a] 618,755	73,928	(f)	(f)	5,948	95,532	.....	(f)	(f)	.....	2,087	54,731	.....	44,774	(f)	72,116	38,141	13,357,295	.....	475,432	.....	(a)	685,156	33,387	2,358,499	(f)	(f)	506,730	20,533,348	1900
1901	2,148,911	[a] 671,303	54,550	(f)	(f)	7,138	100,285	.....	(f)	(f)	.....	4,749	57,004	.....	41,643	(f)	108,774	37,374	14,355,917	.....	404,017	.....	(a)	907,130	49,197	2,283,700	(f)	(f)	564,191	21,795,883	1901
1902	2,552,246	[a] 1,003,393	82,064	(f)	(f)	20,902	126,879	.....	(f)	(f)	.....	5,780	53,463	.....	23,296	(f)	146,099	49,441	16,497,910	.....	560,006	.....	(a)	1,124,572	40,305	2,516,505	(f)	(f)	598,869	25,401,730	1902
1903	2,693,497	[a] 1,053,840	85,546	(f)	(f)	14,194	115,362	(f)	(f)	(f)	.....	1,839	45,107	(f)	11,050	(f)	143,913	49,818	15,650,932	.....	546,875	.....	(a)	1,176,439	45,623	2,707,818	(f)	(f)	932,428	25,274,281	1903
1904	2,340,219	[a] 789,060	75,812	4,439	(f)	9,460	64,112	(f)	(f)	(f)	(f)	2,446	41,497	(f)	58,259	(f)	109,284	44,808	14,861,064	.....	379,240	.....	(a)	1,101,716	45,432	2,283,086	(f)	(f)	1,451,172	23,661,106	1904
1905	2,576,986	[a] 1,378,824	76,593	10,307	.....	4,425	79,487	(f)	(f)	(f)	(f)	1,580	31,482	(f)	89,638	(f)	277,130	54,781	20,573,736	.....	468,092	.....	(a)	1,499,481	53,137	3,400,593	(f)	(f)	1,660,857	32,231,129	1905
1906	3,034,501	[a] 1,455,905	70,280	268,693	.....	1,698	74,064	(f)	(f)	(f)	(f)	.....	38,182	(f)	147,747	(f)	293,994	49,782	23,060,511	.....	483,428	.....	(a)	1,577,659	45,642	3,713,514	(f)	(f)	2,085,617	36,401,217	1906
1907	3,021,794	[a] 1,421,579	74,934	372,697	.....	6,274	67,068	332,253	466,458	(f)	(f)	.....	40,714	256,057	265,125	385,478	270,634	19,089	26,513,214	.....	467,499	.....	(a)	1,545,280	52,028	4,112,896	(f)	.....	1,088,493	40,779,564	1907
1908	2,362,666	[a] 982,291	39,422	362,182	(f)	2,497	37,827	270,916	453,883	(f)	(f)	.....	(f)	248,893	274,565	473,569	159,578	2,944	15,511,634	.....	214,528	.....	(a)	1,162,051	38,889	2,637,123	(f)	.....	798,060	26,033,518	1908
1909	3,085,824	[a] 1,251,805	46,385	1,276,956	(f)	.....	46,371	315,587	444,349	(f)	(f)	.....	(f)	261,460	373,967	523,551	222,711	(f)	24,905,525	.....	261,808	.....	(a)	1,347,478	42,981	3,943,948	(f)	.....	964,359	39,315,065	1909
1910	3,249,027	[a] 1,346,211	43,814	1,514,504	(f)	(f)	53,857	335,373	450,001	(f)	(f)	.....	(f)	250,153	401,646	652,459	282,315	(f)	26,315,607	.....	322,756	.....	(a)	1,493,655	59,337	3,803,850	(f)	.....	1,134,245	41,708,819	1910
1911	2,761,521	[a] 1,177,023	37,553	1,610,212	(f)	(f)	66,099	343,451	477,564	(f)	(f)	.....	(f)	255,334	381,927	686,172	311,382	.....	21,923,935	.....	330,418	.....	(a)	910,411	40,180	2,291,049	(f)	.....	1,947,258	35,551,489	1911
1912	2,975,489	972,941	43,158	1,764,944	2,616,339	(f)	191,555	304,715	511,596	(f)	(f)	.....	.....	304,715	413,906	794,618	388,669	.....	27,438,693	.....	370,076	.....	(f)	967,947	49,260	2,465,986	(f)	.....	1,408,992	43,983,599	1912
1913	3,323,664	879,461	42,747	1,859,553	2,727,025	.....	317,084	236,423	531,384	(f)	(f)	.....	.....	255,792	467,945	758,486	351,846	.....	28,753,444	.....	364,578	.....	(f)	1,303,603	76,221	2,472,752	(f)	.....	1,577,522	46,299,530	1913
1914	3,084,149	666,083	24,517	1,425,168	2,276,652	.....	443,959	87,852	540,631	(f)	(f)	.....	.....	255,283	362,572	457,370	521,638	.....	20,258,393	.....	264,127	.....	(f)	780,984	84,923	1,427,962	(f)	.....	1,593,651	34,555,914	1914
1915	3,071,811	670,938	20,039	1,686,998	2,768,099	.....	526,097	313,283	504,438	(f)	127,847	(f)	.....	269,448	389,411	684,461	684,658	.....	25,622,862	.....	256,973	.....	(f)	629,807	136,552	1,391,446	(f)	.....	1,825,982	41,581,150	1915
1916	4,298,417	1,053,553	47,127	2,320,400	3,489,660	.....	802,526	489,982	563,048	(f)	431,319	(f)	.....	210,766	502,812	775,014	1,803,268	.....	31,279,695	.....	382,175	.....	(g)	1,242,332	[g] 534,653	2,521,309	(f)	.....	1,785,529	54,533,585	1916
1917	4,892,589	1,112,449	39,589	2,289,833	3,540,718	.....	863,071	518,810	595,113	(f)	490,272	(f)	.....	423,361	577,679	993,184	3,694,302	.....	27,912,025	.....	411,326	.....	(g)	1,304,230	[g] 497,533	3,349,761	(f)	.....	2,700,983	55,606,828	1917
1918	4,352,172	989,447	22,048	2,285,610	3,898,215	.....	818,785	474,368	556,397	(f)	784,065	(f)	.....	682,148	597,072	1,069,587	5,365,243	(f)	26,723,645	.....	427,106	.....	(f)	1,234,256	123,788	3,320,006	(f)	.....	2,754,414	56,478,372	1918
1919	3,380,771	613,753	18,149	1,703,903	3,702,180	.....	691,969	356,237	393,331	808,729	586,094	(f)	.....	788,465	260,162	751,067	5,481,660	(f)	20,501,831	(f)	260,915	.....	(f)	930,516	62,546	1,413,932	(f)	.....	1,474,347	44,180,557	1919
1920	4,013,891	789,499	16,523	2,136,793	4,553,697	.....	739,577	682,132	488,089	1,393,445	674,801	(f)	.....	725,571	(f)	1,040,192	5,701,810	.....	23,638,739	(f)	301,708	.....	(f)	1,027,788	59,395	1,828,336	(f)	.....	1,533,057	51,345,043	1920
1921	2,534,039	368,131	6,943	1,322,178	3,091,263	.....	284,825	292,439	294,059	777,125	435,866	(f)	.....	739,768	(f)	746,916	3,028,423	.....	9,769,476	(f)	85,728	.....	(f)	280,476	27,260	397,892	(f)	.....	804,815	25,287,622	1921
1922	3,799,865	484,039	8,832	1,982,906	3,995,505	.....	487,167	589,893	407,081	1,142,059	462,044	(f)	.....	790,811	87,631	1,494,992	5,011,138	.....	13,991,892	(f)	113,896	.....	172,453	378,656	31,674	919,744	(f)	.....	771,734	37,124,012	1922

[a] Utah included with Colorado.
[b] Included with Pennsylvania.
[c] Includes New York.
[d] Indiana included with Illinois.
[e] Includes Massachusetts and New York.
[f] Included with other States having less than three producers.
[g] Utah included with Washington.

Division of Mineral Resources.

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